

Constraint Induced Aphasia Therapy or

Semantic Treatment in Chronic Fluent Aphasia:

A Review and an Explorative Study

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Abstract

Regardless of the type of treatment, highly intensive aphasia therapy may be effective in a predominantly non-fluent aphasia population in the chronic stage of aphasia recovery. The aim of our study is to review the available literature on ‘constraint induced aphasia therapy (CIAT)’ and to investigate in a carefully selected study population of chronic fluent vascular aphasia patients the effectiveness of two highly intensive treatment methods [i.e. CIAT and a semantic treatment (BOX)]. Nine patients were trained three hours a day with the CIAT or the BOX program during 9 consecutive days. Outcome measures included formal language testing, semantic and phonological measures, a therapist administered verbal communication scale and an effectiveness rating of verbal communication by relatives. Study results for the first time show that intensive treatment with both CIAT and BOX establishes a significant improvement of language and communication skills in chronic patients with fluent aphasia. Moreover, semantic training induces selective training effects on semantic measures and leads to bigger improvements in language comprehension and verbal communication. These findings suggest that patients with chronic fluent vascular aphasia benefit more from a highly intensive BOX training than from CIAT .

Keywords: aphasia treatment – communication disorders – language therapy - stroke – linguistics – CIAT

Introduction

Pulvermüller et al. (2001) recently introduced in a randomized clinical trial (RCT) with 17 chronic aphasic patients a new therapeutic approach for chronic aphasia which was coined ‘Constraint Induced Aphasia Therapy (CIAT)’. The principles on which this innovative approach for functional language rehabilitation is based are derived from a substantial body of evidence from experimental studies with nonhuman primates and studies with patients with motor impairments (for a review see Taub et al., 2002). These studies showed that the learned non-use of a paretic limb¹ can be overcome by means of ‘Constraint Induced Movement Therapy (CIMT)²’ in both acute and chronic stroke (Morris et al., 2006; Taub et al., 1999). Pulvermüller et al. (2001) implemented the CI principles in a new aphasia therapy design consisting of: 1) massed practice of speech (30 to 35h of speech therapy in two weeks), 2) shaping (a therapeutic game activity with increasing material difficulty given in small groups of 2 to 3 patients and the therapist) and 3) constraint of compensatory (nonverbal) communication strategies to force aphasic subjects to use verbal language. The group of patients (n=10) that received CIAT significantly improved on clinical aphasia tests and on observation scales of the patients’ communicative effectiveness in everyday life. The patients (n=7) who received conventional therapy (30 to 35h over a period of 4 weeks) did not achieve comparable improvements. Pulvermüller et al. (2001) demonstrated for the first time that a highly intensive treatment of the patients’ communicative needs can have an impact on patients’ linguistic skills as measured by standardized language tests.

Since the introduction of CI therapy in aphasia rehabilitation (Pulvermüller et al., 2001), several clinical studies reduplicated the beneficial findings of the CIAT in a heterogeneous group of chronic aphasia patients (Maher et al., 2006; Meinzer et al., 2005, 2007, 2008; Szaflarski et al., 2008). Meinzer et al. (2005) for the first time showed long-term stability (i.e. after 6 months of therapy) of improved language function in chronic aphasia patients following a treatment with CIAT.

The introduction of the CI principles in aphasia treatment created renewed interest in the phenomenon of therapy intensity or massed practice (Basso, 2005; Boghal et al., 2003; Hinckley & Carr, 2005; Raymer et al., 2008). Studies showed that other aphasia therapies using short-term massed practice had beneficial short- and long-term effects as well (Maher et al., 2006; Barthel et al., 2008). Thus, regardless of the type of treatment used, the effectiveness of a short-term intensive treatment over a restricted time interval has been demonstrated in a heterogeneous population of chronic aphasia patients (for a review see, Cherney et al., 2008). However, the influence of intensity and/or forced use of function (constraint aspect) on aphasia

¹ “...The neglected use of the affected limb follows the acute period after stroke, when physiological damage induces depression of central nervous system and motor activity. Patients will be at this moment encouraged using the unaffected arm induced by the possibility of more effortful movements and by the experience of unsuccessful motor attempts of the paretic limb. These unsuccessful movements lead to punishment and behavioral suppression of the affected limb. Finally, these patients have learned not to use the paretic limb. This ‘learned non-use’ prevents later functional recovery of the limb...” (Taub et al., 2002, p.229)

² CIMT: (1) massed practice of the affected limb (i.e. 6 hours practice 10 or 15 consecutive working days depending of the severity of the deficit), (2) constraint use of the unaffected limb by using a sling, splint or mitt (for 90% of the waking time of the patient) and (3) behavioral shaping training of the paretic limb (i.e. gradually increasing difficulty of the required motor actions).

characteristics (e.g. therapy content, aphasia severity, aphasia type/linguistic impairment, recovery stage, setting and lesion site) remains to be elucidated.

Evidence from a cognitive linguistic therapy approach has shown that specific training at a disrupted language level can have a significant impact on the verbal communication level (Doesborgh et al., 2004). Doesborgh et al. (2004) investigated in a randomized clinical trial (RCT) with 58 aphasic patients the efficacy of a semantic treatment (BOX; Visch-Brink & Bajema, 2001) on everyday language in the first year of recovery (3 to 12 months post onset). All patients with a combined semantic and phonological deficit were included in the study and randomized to receive either the semantic (BOX) or a phonological treatment with FIKS (Van Rijn et al., 2000). Doesborgh et al. (2004) hypothesized that semantic treatment would have a greater effect on every day communication. In contrast to the authors' expectations, both groups showed significant post treatment improvement on the verbal communication outcome measure whereas no significant difference in overall score was found between both groups. In addition, Doesborgh et al. (2004) found selective effects on the semantic and phonological measures. Following the finding that both types of therapy (a functional approach in a highly intensive schedule and a cognitive linguistic approach) influence conversational skills in aphasia, the question arises which kind of treatment (e.g. CIAT or BOX) is optimal for which kind of aphasia type and which kind of linguistic impairment(s) (e.g. semantic deficits, phonological disturbances).

In addition to a critical review of the available CIAT data in the literature, our study primarily investigates for the first time whether CIAT improves impaired language and communication in the chronic stage of recovery in patients with fluent aphasia in whom language skills are affected at a combined phonological and semantic level. In our design, a cognitive linguistic approach (BOX) is used as a comparison condition. As Doesborgh et al. (2004) showed that a pure semantic treatment with BOX has not an impact on phonology we hypothesize that phonological outcome measures will remain unaffected by BOX treatment. Furthermore, we predict that CIAT will have a positive effect on the patient's communication skills and on language functioning (Pulvermüller et al., 2001). Since the literature lacks in-depth linguistic analyses to investigate potential effects of CIAT on specific linguistic measures (e.g. semantics, phonology) no hypothesis can be advanced with regard to the effect of CIAT on specific linguistic levels.

Method

Review of the literature

The relevant literature on CIAT was identified through searches of electronic databases (Medline, PsycINFO, Omega, Google Scholar) using the keywords aphasia treatment, aphasia therapy, language disorders, intensity, constraint, rehabilitation, functional communication, communication disorders. In addition, bibliographies of all relevant articles were scanned to identify additional references. Only first source information was analyzed, second or third-line references to original contributions were not taken into consideration. Abstracts and poster presentations were not included. Articles dated from the first study by Pulvermüller et al. in 2001 to the study of Szaflarski et al. (2008). Only the CIAT studies which were focused on language behavioural measurement outcomes were included for analyses. We only included the cases that re-emerged in the CIAT studies once. For example, Meinzer et al. (2008) reported the pre and post language performances of 11 participants after CIAT. Six of these eleven patients had been described in Meinzer et al. (2007). We did not analyze the data of the participants who received a comparison therapy because our focus was on the CIAT treatment group.

Design

The current study explores behavioural treatment outcomes of two therapeutic approaches (CIAT and BOX) in chronic patients with fluent aphasia after an ischemic stroke. Data were obtained in a two factorial split-plot design with one between-subject factor ‘therapy condition’ with two levels (CIAT, BOX) and one within-subject factors ‘time’ with two levels (pre-test, post-test). The participants were randomly assigned in dyads or triads of participants to the semantic treatment (BOX) or CIAT. The participants were formally tested at two different time points during the study: 1) before the treatment (a pre-test) and 2) and one week after treatment to check which therapy condition is the most effective to treat combined phonological and semantic disorders in chronic aphasia (a post-test). Assessments were distributed among two experienced assessors. Test results were obtained independently from each other.

Participants

Participants were recruited from the ‘Ziekenhuis Netwerk Antwerpen (ZNA)³’ aphasia database and via speech and language therapists from 13 Antwerp clinical centers who referred patients for screening and possible inclusion. Speech and language therapists were fully informed about the in- and exclusion criteria. Only patients who were suffering from chronic fluent aphasia following a stroke in the left hemisphere were considered for inclusion. Fluent aphasia was defined as Wernicke aphasia, transcortical (TC) sensory aphasia, conduction aphasia and anomic aphasia according to a classic taxonomic classification (Boston

³ Recruitment channels: Seven hospitals of the “Ziekenhuis Netwerk Antwerpen” (ZNA) which is a network of hospitals in the region of Antwerp: ZNA ‘Middelheim’, ZNA ‘Sint-Elisabeth’, ZNA ‘Stuivenberg’, ZNA ‘Jan Palfijn’, ZNA ‘Sint -Erasmus’, ZNA ‘Hoge Beuken’ and ZNA ‘Joostens’, ‘Centrum voor Epilepsie en Psycho-Organische Stoornissen (CEPOS)’ Duffel, ‘Hof Ter Schelde’, ‘Sint Vincentius’ Hospital, ‘Sint Augustinus’ Hospital, ‘Klinieken Noord-Antwerpen (KLINA)’ Brasschaat and a regional speech and language therapists’ clinical practice.

School of Aphasia). Since recovery in most aphasic patients reaches a plateau after one year (Berthier, 2005; Robey, 1998), all patients were in the chronic stage of stroke recovery as defined by a symptom duration of at least 12 months. The participants had received intensive speech and language therapy and had been considered to have reached an apparent maximum recovery of aphasia. None of the patients followed any kind of therapy between the pretesting and the intervention period. Only literate patients, who prior to the stroke were fully competent native speakers of Dutch were included in the study. Patients with an associated neurological or psychiatric disorder or with psychiatric antecedents were excluded from the study. Participants with perceptual, speech (e.g. apraxia of speech) and/or cognitive deficits were excluded in the screening phase of the study. All participants were screened with regard to visuo-perceptual problem solving skills by means of the Raven (Coloured) Progressive Matrices (Raven, 1976) and all performed above the 75th percentile.

Only patients with moderate language impairments were included in our study because (1) CIAT requires similar levels of severity in the treatment groups and (2) we aimed to achieve as much as possible a homogeneous group of aphasia patients. Severity of aphasia was determined by the Stanine-norms on the 'Token Test (TT)' of the Dutch version of the 'Aachener Aphasia Test (AAT)' (Graetz et al., 1990). For diagnostic purposes, the AAT and the 'Boston Naming Test (BNT)' (Kaplan et al., 1983; Mariën et al., 1998), were administered. In addition, only fluent aphasic patients with a combined semantic and phonological deficit and with a verbal communication disorder were included. Criteria for a semantic deficit were (1) a score below 2 standard deviations (SD) of normal performance on at least one of the following semantic tasks : 'Verbal Semantic Association Test (VSAT)' (Visch-Brink et al., 1996), 'Auditory Synonym Judgment (ASJ)' (Dutch version of the Psycholinguistic Assessment of Language Processing in Aphasia (PALPA) subtest 47; Bastiaanse et al., 1995), 'Semantic Word Association of Low Imageability words (SWALI)' (PALPA subtest 49), and (2) AAT 'Comprehension (CO)' below cutoff. Evidence for a phonological deficit was based on a performance below 2 SD of normal performance on at least one of the following tests (1) AAT 'Repetition (RE)', (2) 'Non-word Repetition (NR)' (PALPA subtest 8) or (3) 'Auditory Lexical Decision (ALD)' (PALPA subtest 5). The performance of the participants on the 'Amsterdam Nijmegen Everyday Language Test (ANELT)' scale A (Blomert et al., 1995) was used to evaluate the presence and severity of the verbal communication deficit. Unlike the Pulvermüller study (Pulvermüller et al., 2001), we preferred a therapist-administered measure of verbal communication to exclude a possible bias regarding the subjectivity of self-reported measures (Meinzer et al., 2005). In addition, the effectiveness of verbal communication in everyday life was measured by means of a Dutch translation of the 'Communicative Effectiveness Index (CETI)' (Lomas et al., 1989; Schlenck & Schlenck, 1994). Handedness was formally assessed by means of a standard handedness inventory (Oldfield, 1971).

Potential treatment candidates and their relatives were invited to participate in the study. They were fully informed about the rationale and practical organisation of the study. For example, patients and relatives from both groups were told that they were going to participate in an aphasia therapy study that uses a specific intensity format and that required extensive testing before and after treatment. Informed consent was obtained from each participant. The study was approved by the local ethical committee of ZNA Middelheim. Nine out of a cohort of 100 patients carefully screened for inclusion entered the study.

Intervention Procedures (CIAT and BOX)

Two types of treatment were given by trained speech and language pathology students (3rd bachelor level). During the first two days of the 9 to 10 training days the students remained under the supervision of experienced and professionally trained speech and language therapists. Laypersons were trained according to the protocol designed by Meinzer et al. (2007). In addition to the students, speech and language therapists from eight hospitals⁴ were profoundly instructed by means of a two hours presentation in which the pilot-study was presented. The basic principles of CIAT were introduced and the materials, procedures and approaches of both interventions were thoroughly explained. In addition, students were given a one hour practical training session. Instruction sessions contained illustrative video material. The students and therapists received a detailed manual with explicit guidelines about the CIAT and the BOX (Appendixes 1 and 2).

Finally, five intervention sessions (two CIAT sessions and three BOX sessions) were organised in four different hospitals⁵. All patients either received CIAT or BOX training during 2 to 3 hours sessions per day on 9 or 10 consecutive working days (mean total 1175 ± 64 minutes, pauses not included). There was no significant difference in the amount of training between the CIAT group (total mean duration 1195 minutes, SD ± 59 minutes) and the BOX group (total mean duration 1150 minutes, SD ± 69 minutes) when mean durations in minutes were compared ($t_7 = 1.1$, $p=0.328$). Per session three breaks of 10 to 15 minutes were introduced for practical reasons.

The students and therapists wrote a daily script about each intervention. The presence of the participants and therapists, the duration of the training in minutes and the material used during the sessions was specified. Observations and findings were reported in detail. The script was used for a daily evaluation and critical discussion between the students and the supervisor about the findings from that session and how to adjust individual or group task difficulty for the next day.

The main differences between the experimental therapy (CIAT) and the comparison condition (BOX) was the setting, group versus individual therapy respectively, and the treatment condition, namely communication versus semantics.

⁴ Seven hospitals of the ZNA in Antwerp and CEPOS in ‘Duffel’

⁵ ZNA ‘Middelheim’, ZNA ‘Jan Palfijn’; ZNA ‘Sint -Erasmus’; ‘CEPOS’ Duffel

CIAT-intervention (see Dutch written manual, Appendix 1)

The intervention procedure was based on Maher et al. (2006), Meinzer et al. (2005, 2007) and Pulvermüller et al. (2001). The therapy game activity was performed in groups of two to three patients. One or two therapists participated in each CIAT group. Constraint was operationally defined as limiting the response to spoken production only. Meinzer et al. (2007, p. 848) argued that (1) gestures might actually facilitate spoken language and (2) “...Substantial data suggest that restraint makes actually a relatively small contribution to treatment outcome in motor rehabilitation (for a recent review, see Morris et al., 2006)...” Therefore, we allowed patients to use gestures if it facilitated verbal output. However, barriers with a height of 40 cm in front and on either side of each patient prevented the participants from observing non-verbal communication behaviours (e.g. gestures, pointing) (Figure 1). As a result, gestures did not act as a primary means in communication. In addition, participants were encouraged to use any kind of verbal communication.

The game was played with a set of 32 to 42 coloured cards (=16 to 21 pairs of identical cards) per 45 minutes training. The participants had to chose one card at every turn ($n= 4$ to 6 cards per 45 minutes). Without showing this card to the other players, a questioner explicitly addressed a co-player, asking for this particular card by means of a verbal description (e.g. John, can you give me the card on which a red ball is depicted?). The “receiver” was instructed to answer with an explicit reply (e.g. Mary, I can not give you the card on which a red ball is shown). The purpose was to collect as much paired cards as possible.

According to Pulvermüller et al. (2001, p. 1622): “...Constraints will be introduced to force patients to use verbal language and to challenge their communicative capacity...” . These constraints were along three dimensions: (1) difficulty of the material, (2) shaping and the rules of the game and (3) reinforcement contingencies (Pulvermüller et al., 2001).

Figure 1 CIAT session in ZNA Middelheim



Material constraints

All words represented by pictures of objects and actions ($n=450$) were classified for lexical frequency (high, middle and low frequency words; Appendix 3) according to the database CELEX (Centre for Lexical Information; Bayen et al., 1993). In the first sessions, only simple black and white line drawings of objects ($n=249$) were used. These drawings were taken from an internet database (Szelekely et al., 2004). Later on, coloured pictures of objects from different semantic categories or themes, action cards, sentences cards (internet database ‘Imagine Symbols’, 2004) and pictures with minimal pairs were introduced. Thus, the therapist triggered a more advanced communication by means of (1) decreasing word frequency, (2) introducing coloured pictures from the same semantic category or theme, (3) using action or sentence cards and (4) requesting the exact pronunciation by using cards of phonetically minimal pairs. Because of the moderate severity of language impairment in both CIAT groups, the participants almost exclusively practiced with low frequency picture cards.

Shaping and rules constraints

In the first session, participants were allowed to use any relevant verbal expression to obtain a particular card. The therapist provided as much cueing as necessary for a successful expression. Cueing strategies that were used consisted of: semantic cueing, phonological cueing, selecting, repeating or a reminder/visual cueing. These verbal expressions and cueing strategies were gradually constrained by (1) the introduction of explicit rules and (2) shaping and modelling. The rule of constraining allows the players (1) to use the names of the co-players, (2) to use politeness rules and (3) to use more complex verbal expressions. For example, Rosa asked Johanna: “Johanna, do you have the card with a green bird on it?” Johanna answered as follows: “No Rosa, I don’t have the card with a green bird on it. That’s a pity, isn’t it?” When passing the cards to each other, participants were always asked to use politeness expressions like “please”, “here you are” or “thank you”. To encourage the self cueing capacities of the patients in a communication setting and to introduce the use of more complex verbal expressions, the questioner was sometimes asked to give only a description of the object. The receiver was expected to name the object. Following the shaping principle, the cueing strategies were gradually reduced. Finally, the participants were encouraged to communicate without any help.

Reinforcement contingencies

Because we composed groups based on a similar degree of linguistic impairment, the rules and shaping principles could be performed on a group basis. Every one could practice with the same rules and constraints.

BOX-intervention (see Dutch written manual, Appendix 2)

The patients in the BOX-group (n=4) received individual training according to a particular therapy schedule (Figure 2) which allowed one therapist to supervise two patients . For example, on the first day, patient number one started with 30 minutes of therapy (therapy schedule 1) whereas patient number two began with 30 minutes as an individual working session (therapy schedule 2). The next day participants changed from therapy contents. A similar strategy was applied when a single patient was treated with BOX.

The BOX-program contains a variety of semantic decisions tasks (multiple choice, right/wrong format) aimed to train and improve semantic processing. Semantic processing could be trained on several levels of difficulty with the following factors: number of distractions, strength of the semantic relationship and frequency and abstractness of the word. Thus, every patient could enhance his personal level of difficulty. In order to apply the shaping principle, therapists always took care that the patients trained at a level of difficulty that challenged them without frustrating them.

Therapists stick to the manual of the BOX treatment program. Because of the intensive nature of the training (three hours a day/9days), the amount of exercises was limited and the need of variation in the exercises was forced up. Therefore, the therapists extended the exercises with variations on the original semantic tasks which are exactly described in the original manual of the BOX program..

Figure 2 Therapy schedule 1 and 2

Therapy schedule	
1	2
A: 30 Therapy session	A: 30 Individual work session
B: 15 Individual work session	B: 15 Therapy session
pause	pause
A 30 Individual work session	A 30 Therapy session
B 15 Therapy session	B 15 Individual work session
pause	pause
A 30 Therapy session	A 30 Individual work session
B 15 Individual work session	B 15 Therapy session
75 Therapy session	60 Therapy session
60 Individual work session	75 Individual work session

Legend: A=first part of 45 min (30 min), B=last part of 45 min (15min)

Outcome Measures

The primary outcome measure of the study was the ANELT. Only the A-scale of the ANELT was performed by the patients. During the post treatment session, the clinicians administered a parallel version of the ANELT (ANELT II). Patients were asked to give verbal responses in 10 everyday language scenarios. These responses are scored with regard to the comprehensibility of the message on a 5-point scale (0= not at all – 5 =good). The responses of the patients were video-taped and scored by two experienced aphasiologists. In addition, the quality of verbal communication in everyday life was measured by means of a Dutch translation of the CETI, which is a 16-item analogue scale scored by the patients' relatives (Appendix 4). Relatives were blinded to the pre-treatment scores.

The second outcome measures consisted of phonological and semantic parameters. The phonological measure consisted of the NR test (PALPA test 8) and the ALD task (PALPA test 5). In the ALD task the patient has to indicate whether an auditory perceived word is a non-word or not. The semantic measure consisted of the VSAT, the SWALI (PALPA test 49) and the ASJ test (PALPA test 47). In the VSAT and in the SWALI test (PALPA test 49) the patient chooses from 4 written alternatives the word that is semantically most closely related to the given stimulus word. In the ASJ test of the PALPA (test 47) the patient judges whether two words are synonyms or not.

The AAT is a standardized diagnostic language test battery that has been frequently used as an outcome measure in previous CIAT studies (Meinzer et al., 2005, 2007, 2008; Pulvermüller et al., 2001). The AAT comprises five subtests: the Token Test (TT), repetition tests (RE), written language tests (WL), naming tests (NA) and comprehension tests (CO). The AAT has a high test-retest reliability (two-day interval: retest reliability > .91 for all subtests in chronic aphasia patients; Graetz et al., 1990, p.96). Since naming is a sensitive measure outcome for any linguistic improvement in aphasia, the BNT, a visual picture-naming task consisting of 60 outline drawings of objects and animals, was additionally performed. The well-being of the participants was rated by means of a seven point scale (0 = not agree, 7 = strongly agree, Appendix 5).

Data Analysis

The relationships of categorical variables were analyzed with the χ^2 test. Because of the small sample size a non-parametric statistical analysis (i.e. a Mann-Whitney test or a Wilcoxon test) was added to the parametric statistical analysis of the linguistic data. Because the findings of both procedures were similar, only the findings of the parametric statistical analysis will be reported.

Differences in mean scores within and between groups on the ANELT, CETI, semantic measures and phonological measures were compared by means of two-tailed t-tests. The effect sizes were derived

from within-group comparisons of the pre and post difference mean score from each treatment ($d = \frac{(m1 - m2)}{s}$; Cohen, 1988). Critical changes in raw scores were discussed on an individual basis for all measurement outcomes. The AAT and the BNT raw scores at the first assessment and across training were evaluated using a repeated measures analyses of variance with the between-subject factor GROUP and the within-subject factor TIME.

Results

Review of the literature

Table 1 displays number of patients, mean age at treatment, gender, mean educational level, handedness, type of stroke, mean months post onset, aphasia syndrome and aphasia severity for all CIAT studies published in the literature since 2001 (Barthel et al., 2008; Maher et al. 2006; Meinzer et al., 2005, 2007, 2008; Pulvermüller et al., 2001; Szaflarski et al., 2008). As demonstrated in table 1, 69 right-handed chronic aphasia patients were treated with CIAT and 24 patients with either the Promoting Aphasic Communicative Effectiveness (PACE) therapy or the model-orientated aphasia therapy (MOAT) or a conventional aphasia treatment (CAT). We analysed the 69 cases recorded in the CIAT studies (Maher et al., 2006; Meinzer et al., 2005, 2007, 2008; Pulvermüller et al., 2001; Szaflarski et al., 2008). Appendix 6 shows the data on age at treatment, gender, handedness, educational level, months post onset, aetiology of CVA, aphasia syndrome and aphasia severity for the 69 CIAT patients.

Mean age of this study corpus was 53.3 years ($SD \pm 12.6$ years; range 18 to 80 years). 46 out of 69 patients (66.7%) were men (case nr. 2-5, 8, 10-11, 13-14, 16-17, 19-20, 23-24, 26-28, 31, 33, 35-36, 38-44, 46-47, 50-53, 55-57, 60-61, 63-64, 66-69) and 23 (33.3%) were women (case nr. 1, 6-7, 9, 12, 15, 18, 21-22, 25, 29-30, 32, 34, 37, 45, 48-49, 54, 58-59, 62, 65). A significant gender difference was found since more men were studied than women ($\chi^2 = 34.5$, $p < 0.001$) with no trend in age and gender ($t_{66} = 0.46$; $p = 0.646$).

Handedness was not reported in 27 CIAT patients (39.1%) [case nr. 11-37]. Thirty-nine patients (56.5%) were right-handed and three patients (4.3%) were ambidextrous.

Mean years of education of 36 out of 69 patients (52.2%) [case nr. 1-10, 38-57, 63-66, 68-69] was 11.63 years ($SD \pm 2.2$ years, range 9 to 16 years) whereas years of education was not reported for 33 patients (47.8%) [case nr. 11-37, 58-62, 67].

Approximately, 76 % of the patients suffered from a left hemispheric infarction (=76.3% = 45/59; case nr. 11-14, 18, 20-21, 23-25, 28-31, 35-36, 38-47, 49-55, 57, 59-69). A left hemisphere haemorrhage was reported in 23.7% (=14/59) of the patients (case nr. 15-17, 19, 22, 26-27, 32-34, 37, 48, 56, 58). Pulvermüller et al. (2001) not specified whether the patients suffered from an infarction or from a haemorrhage (n=10, case nr. 1-10). In the corpus of 59 patients with vascular left hemispheric lesions, there were significantly more infarctions than haemorrhages ($\chi^2 = 49.0$, $p < 0.001$). The mean-age for the infarction group was 54.7 years ($SD \pm 11.2$ years, range 35 to 80) and 47.4 years ($SD \pm 16.5$ years, range 18

to 70) for the haemorrhage-group. Both groups were not significantly different with regard to age ($t_{56} = 1.9$, $p=0.063$).

Mean time post onset was 58.6 months (68 patients, $SD \pm 69.4$, range 6 to 480 months). For one patient (case nr. 67) no data were available.

In the group of 69 CIAT participants 37 (53.6 %) patients presented with non-fluent aphasia (i.e. 33 Broca aphasia and 4 global aphasia; case nr. 4-9, 22-31, 37, 43-53, 55-61, 68-69) and 20 (29.0 %) patients presented with fluent aphasia (i.e. 14 Wernicke aphasia and 6 anomia aphasia, case nr. 1-3, 11-21, 38-42, 67). For the remaining group of 12 (17.4 %) patients no taxonomic label was provided (case nr. 10, 32-36, 54, 62-66). There were significantly more non-fluent patients than fluent patients ($\chi^2 = 5.1$, $p=0.024$) with no significant difference in mean age ($t_{54} = -0.4$, $p=0.668$). The mean age of the fluent group was 52.0 years ($SD \pm 13.6$ years, range 18 to 72 years) and 53.5 years ($SD \pm 11.4$ years, range 35 to 80 years) for the non-fluent group. A significant gender difference was found with regard to the fluency parameter. Significantly more women in the CIAT population developed fluent aphasia types ($\chi^2 = 10.4$, $p<0.001$).

Regarding the severity of the aphasia appendix 7 shows that 11 (15.9%) patients were severely impaired (case nr. 2, 8-9, 36-37, 53, 55-57, 67, 69), 36 (52.2%) had moderate aphasia (case nr. 1, 5-7, 10, 13-18, 25-31, 34-35, 38-40, 49-52, 54, 60-66, 68) and 22 (31.9%) were mildly impaired (case nr. 3-4, 11-12, 19-24, 32-33, 41-48, 58-59). A significant disproportion of severity distribution was found in this cohort of aphasia patients ($\chi^2 = 13.7$, $p=0.001$). No significant relation between the variables severity and fluency was found ($\chi^2 = 1.4$, $p=0.5$). No significant difference in mean age was found between the severity groups ($F_2 = 1.4$, $p=0.246$) with a non-significant trend in gender and severity ($\chi^2 = 1.4$, $p=0.509$).

Table 2 presents the characteristics and results of the seven CIAT studies to inclusion and exclusion criteria, number of participants, performed therapies, intensity of treatment (i.e. hours and period), language and communication tests, measurement outcomes and results. Regardless of the type of treatment a highly intensive treatment of 30 hours in 10 days has a positive effect on language and communication skills in a heterogeneous group of chronic vascular aphasia patients (Pulvermüller et al., 2001; Maher et al., 2006; Meinzer et al., 2005, 2007, 2008; Barthel et al., 2008). Szaflarski et al. (2008) demonstrated training effects on language (i.e. comprehension and naming) measures after 15 to 20 hours CIAT therapy spread out over five consecutive days in three chronic aphasia patients. However, these authors found no improvements on the subjective communication questionnaire. In addition, findings in the CIAT literature suggest that the impact of intensity could be separated from the impact of the type of treatment (Barthel et al., 2008; Maher et al., 2006; Meinzer et al., 2005).

Table 1 CIAT studies, number of patients, mean age at treatment, gender, educational level, handedness, etiology of stroke, months post onset, aphasia syndrome and aphasia severity

Author	Group	n	Handedness (n)	M-Age in y (SD)	M-Education in y (SD)	Sex (n)	Etiology (n)	Months PO (SD)	Aphasia Type							Severity				
									Broca	Global	Wernicke	Anomic	Conduction	TC	Not Labelled	NR	Se	Mo	Mi	Se/Mo
Pulvermüller et al. (2001)	CIAT	10	RH (8); AD (2)	55,4 (10,9)	11,1 (1,7)	M (6); F (4)	I/H (10)	98,2 (74,2)	6	0	2	1	0	1	0	0	3	5	2	0
	CAT	7	RH (6); AD (1)	53,9 (7,4)	10,9 (2,0)	M (6); F (1)	I/H (7)	24,0 (20,6)	4	0	2	0	1	0	0	0	1	4	2	0
	Tot	17	RH (14); AD (3)	54,8 (9,4)	11,0 (1,8)	M (12); F (5)	I/H (17)	67,6 (68,6)	10	0	4	1	1	1	0	0	4	9	4	0
Meinzer et al. (2005)	CIAT	12	NR	50,1	NR	M (8); F (4)	I (7); H(5)	46,2	4	0	4	2	0	0	2	0	1	5	6	0
	CIATplus	15	NR	52,1	NR	M (8); F (7)	I (9); H (6)	47,9	6	1	4	1	0	0	3	0	1	10	4	0
	Tot	27	NR	51,5 (13,8)	NR	M (16); F (11)	I (16); H(11)	47,1	10	1	8	3	0	0	5	0	2	15	10	0
Maher et al. (2006)	CIAT	4	RH (3); AD (1)	48	15	M (3); F (1)	I (4); H (0)	38	0	0	0	0	0	0	0	4	0	4	0	0
	PACE	5	RH (5); AD (0)	58	15	M (3); F (2)	I (5); H (0)	35	0	0	0	0	0	0	0	5	0	5	0	0
	Tot	9	RH (8); AD (1)	53,6 (11)	15 (1,7)	M (6); F (3)	I (9); H (0)	36,9 (17,1)	0	0	0	0	0	0	0	9	0	9	0	0
Meinzer et al. (2007)	CIAT/A	10	RH (10); AD (0)	50,2	11	M (7); F (3)	I (9); H (1)	30,7	7	2	0	0	0	0	1	0	2	3	5	0
	CIAT/B	10	RH (10); AD (0)	62	11	M (9); F (1)	I (9); H (1)	46,5	4	1	3	2	0	0	0	0	1	6	3	0
	Tot	20	RH (20); AD (0)	56,1 (11,1)	11 (1,72)	M (16); F (4)	I (18); H (2)	38,6 (19,36)	11	3	3	2	0	0	1	0	3	9	8	0
Barthel et al. (2008) (Meinzer et al., 2005)	MOAT	12	RH (12); AD (0)	55,2 (14,2)	10 (1,9)	M (5); F (7)	I (8); H (4)	64 (49,2)	8	1	0	1	0	0	2	0	0	7	5	0
	(CIATplus) (27)																			
Meinzer et al. (2008) (Meinzer et al., 2007)	CIAT	5*	RH (5); AD (0)	48,4 (18,7)	NR	M (2); F(3)	I (4); H (1)	113,4 (205,1)	4	0	0	0	0	0	1	0	0	3	2	0
	(CIAT/A-B) (6)																			
Szaflarski et al. (2008)	CIAT	3	RH (3); AD (0)	R (58-64)	14,6 (NR)	M (3); F (0)	I (3); H (0)	R (12-240)	2	0	1	0	0	0	0	0	0	0	0	3
Total	CIAT	69	RH (39); AD (3); NR (27)	53,3 (12,6)	12,5 (2,1)	M (46); F (23)	I (45); H (14); I/H (10)	60,1(32,1)	33	4	14	6	0	1	7	4	8	36	22	3
	Other	24	RH (23); AD (1); NR (0)	55,7 (2,1)	12 ,1(2,7)	M (14); F (10)	I (13); H (4); I/H (7)	41,0(20,7)	12	1	2	1	1	0	2	5	1	16	7	0
	Total	93	RH (62); AD (4); NR (27)	54,6 (5,2)	12,3 (2,1)	M (60); F (33)	I (58); H (18); I/H (17)	54,4(29,4)	45	5	16	7	1	1	9	9	52	29	3	

5*: case 1, 4, 6, 10,11

Legend

AD=Ambidextrous

CAT=Conventional Aphasia Therapy

CIAT =Constrained Induced Aphasia Therapy

CIAT A/B=CIAT by therapists/CIAT by Laypersons

CIAT plus=Including written materials and photographs

of everyday situations and a training module including a patients relative

in daily individual communication exercises

I/H=Ischemic/Hemorrhagic

F=Female

MOAT=Model Orientated Aphasia Therapy

NFI=Non Fluent

NR=Not Reported

PACE = Promoting Aphasic Communicative Effectiveness

PO = post onset

R ()=Range ()

RH=Right Handed

Se=severe

TC=Transcortical

Table 2 CIAT studies, inclusion and exclusion criteria, number of participants, performed therapies, intensity of treatment (i.e. hours and period), language- and communication tests, measurement outcomes and results.

Auteur(s)	Inclusion	Exclusion	n	Therapies	Hours	Period	Speech & Language Tests	Measurement Outcome	Summary of the Results
1, Pulvermüller et al. (2001) RCT	ChA I/H - LH (perisylvian a., CT/MRI) Monoling. native German sp.	Severe perceptual/cogn.def. Additional neurol.diag. LH pat Depression (DSM-IV-crit.)	17	CIAT- CAT	30 à 35	10wd - 4/5w	AAT (TT,C,N & R) AAT -profile CAL	Pre- post therapy L/Co results Between (GROUP) and within (TIME) gr. results Performance increase (percentile values)	CIAT sign improvement (L/Co) CIAT : TT, N & C sign improvement AAT: 17% (CIAT) - 2% (CAT) CAL: 30% (CIAT) - No Improvement (CAT) CIAT/CIATplus sign. improvement (L/Co) Improvements stable across F-up (L); CIATplus (Co) Improvement on profile & all subtests (AAT) Total 85 % subj.improved a.1.one sub/ subscale (L) Individ. Improv. NOTcorrelated with age, time po Number of improved subtests & severity Correlation changes AAT & m of Co
2, Meinzer et al. (2005) RCT	ChA I/H - LH	Severe global aphasia Severe perceptual/cogn.def.	27	CIAT - CIAT plus further treatment	30 1,5 & 1,7/w	10wd 6 mo (E-F-up)	AAT (TT, C, N, R & W) AAT -profile CAL CETI	Pre- post therapy L/Co results Follow-up (6 mo post treatment) L/Co Between (GROUP) and within (TIME) gr. results Correlation indiv.improvement with age/time po Number of improved subtests & severity Correlation changes AAT & m of Co	No correlation between changes in AAT & funct Co Sign.change pre/post therapy (WAB, BNT, ANT) No sign.group difference Continuing gains for CIAT No Continuing gains for PACE Mount of pre-post change > for CIAT Confounder: severe AoS in PACE group Improvement of narrative skills MIGHT be > for CIAT Training gains similar for both groups Aphasia Severity was sign reduced in A&B Individual Analysis: sign improvement in a.l. (1)one AAT subtest (A:n=7; B:n=7; N=10)(2) one subsc. (A: n=3; B: n=2). Pat.1(B) NO improvement. MOAT sign improvements (L/Co) - Stable in F-up MOAT/CIAT plus no sign diff. in L results MOAT/CIAT sign differences in W (L) - perc/prod (Co) MOAT AAT: C (large) , TT/R/W (medium), N (small) MOAT CAL/CETI: medium to large (F-up) Naming: sign improvement-general, to untrained items Sign improvement on all subets (AAT) Aphasia Severity was sign reduced Sign improvement on naming test Behavioral gain mediated by perilesional areas Substantial improvements in comprehension (2/3) Story retell: Increase in N words and N utterances (2/3) No subj. Impovements on mini-CAL
3, Maher et al. (2006) CT	(motivated, interested) ChA (a.l. 12mo. p.o.) I/H Single LHe RH English Speaking Received SL intervention Pat with AoS were included	Additional/premorbide neurol. impairments Learning Disability Discharged from therapy prior to partic. the study Severe to moderate depression	9	CILT - PACE	24	10wd	AQ (WAB) BNT raw score ANT raw score ABA-2 retelling Cinderella story (QPA)	Pre- post therapy L results Between (GROUP) and within (TIME) gr. results Follow-up (1 mo post treatment)	No correlation between changes in AAT & funct Co No sign.group difference Continuing gains for CIAT No Continuing gains for PACE Mount of pre-post change > for CIAT Confounder: severe AoS in PACE group Improvement of narrative skills MIGHT be > for CIAT Training gains similar for both groups Aphasia Severity was sign reduced in A&B Individual Analysis: sign improvement in a.l. (1)one AAT subtest (A:n=7; B:n=7; N=10)(2) one subsc. (A: n=3; B: n=2). Pat.1(B) NO improvement. MOAT sign improvements (L/Co) - Stable in F-up MOAT/CIAT plus no sign diff. in L results MOAT/CIAT sign differences in W (L) - perc/prod (Co) MOAT AAT: C (large) , TT/R/W (medium), N (small) MOAT CAL/CETI: medium to large (F-up) Naming: sign improvement-general, to untrained items Sign improvement on all subets (AAT) Aphasia Severity was sign reduced Sign improvement on naming test Behavioral gain mediated by perilesional areas Substantial improvements in comprehension (2/3) Story retell: Increase in N words and N utterances (2/3) No subj. Impovements on mini-CAL
4, Meinzer et al. (2007) RCT	ChA (a.l. 6 mo. p.o.) I/H Single LHe 2 pat with mild AoS Pat. with global aphasia only with residual expressive language capacities	Patients with min lang.sympt. Neurol./psychiat. Disorders Participation in an other rehabilitation programme during the training	20	CIAT/A - CIAT/B	30	10wd	AAT (TT, C, N, R & W) AAT-Profile	Pre- post therapy L results Between (GROUP) and within (TIME) gr. results	No correlation between changes in AAT & funct Co No sign.group difference Continuing gains for CIAT No Continuing gains for PACE Mount of pre-post change > for CIAT Confounder: severe AoS in PACE group Improvement of narrative skills MIGHT be > for CIAT Training gains similar for both groups Aphasia Severity was sign reduced in A&B Individual Analysis: sign improvement in a.l. (1)one AAT subtest (A:n=7; B:n=7; N=10)(2) one subsc. (A: n=3; B: n=2). Pat.1(B) NO improvement. MOAT sign improvements (L/Co) - Stable in F-up MOAT/CIAT plus no sign diff. in L results MOAT/CIAT sign differences in W (L) - perc/prod (Co) MOAT AAT: C (large) , TT/R/W (medium), N (small) MOAT CAL/CETI: medium to large (F-up) Naming: sign improvement-general, to untrained items Sign improvement on all subets (AAT) Aphasia Severity was sign reduced Sign improvement on naming test Behavioral gain mediated by perilesional areas Substantial improvements in comprehension (2/3) Story retell: Increase in N words and N utterances (2/3) No subj. Impovements on mini-CAL
5, Barthel et al. (2008) (Meinzer et al., 2005) CT	ChA I/H LHe Native speakers in German	Severe global aphasia Severe AoS/dysarthria Severe perceptual/cogn.def. Depression	12 (27)	MOAT (CIAT-CIATplus)	30 (30)	10wd (10wd)	AAT (TT, C, N, R & W) Naming Test CAL	Pre- post therapy L/Co results Follow-up (6 mo post treatment) L/Co Between (GROUP) and within (TIME) gr. results Effects sizes	No correlation between changes in AAT & funct Co No sign.group difference Continuing gains for CIAT No Continuing gains for PACE Mount of pre-post change > for CIAT Confounder: severe AoS in PACE group Improvement of narrative skills MIGHT be > for CIAT Training gains similar for both groups Aphasia Severity was sign reduced in A&B Individual Analysis: sign improvement in a.l. (1)one AAT subtest (A:n=7; B:n=7; N=10)(2) one subsc. (A: n=3; B: n=2). Pat.1(B) NO improvement. MOAT sign improvements (L/Co) - Stable in F-up MOAT/CIAT plus no sign diff. in L results MOAT/CIAT sign differences in W (L) - perc/prod (Co) MOAT AAT: C (large) , TT/R/W (medium), N (small) MOAT CAL/CETI: medium to large (F-up) Naming: sign improvement-general, to untrained items Sign improvement on all subets (AAT) Aphasia Severity was sign reduced Sign improvement on naming test Behavioral gain mediated by perilesional areas Substantial improvements in comprehension (2/3) Story retell: Increase in N words and N utterances (2/3) No subj. Impovements on mini-CAL
6, Meinzer et al. (2008)	ChA I/H LHe	NR	11	CIAT	30	10 wd	AAT (TT, C, N, R & W)/ AAT-Profile picture naming test	Pre- post therapy L results Pre-Post fMRI Pre-MEG assesment	No correlation between changes in AAT & funct Co No sign.group difference Continuing gains for CIAT No Continuing gains for PACE Mount of pre-post change > for CIAT Confounder: severe AoS in PACE group Improvement of narrative skills MIGHT be > for CIAT Training gains similar for both groups Aphasia Severity was sign reduced in A&B Individual Analysis: sign improvement in a.l. (1)one AAT subtest (A:n=7; B:n=7; N=10)(2) one subsc. (A: n=3; B: n=2). Pat.1(B) NO improvement. MOAT sign improvements (L/Co) - Stable in F-up MOAT/CIAT plus no sign diff. in L results MOAT/CIAT sign differences in W (L) - perc/prod (Co) MOAT AAT: C (large) , TT/R/W (medium), N (small) MOAT CAL/CETI: medium to large (F-up) Naming: sign improvement-general, to untrained items Sign improvement on all subets (AAT) Aphasia Severity was sign reduced Sign improvement on naming test Behavioral gain mediated by perilesional areas Substantial improvements in comprehension (2/3) Story retell: Increase in N words and N utterances (2/3) No subj. Impovements on mini-CAL
7, Szaflarski et al. (2008)	ChA (> 2 y duration; 2-20 y) I	Difficulty understanding the consent procedure 7/12 or higher on RCPM	3	CIAT-Mod	15 à 20	5wd	BDAE story retell (BDAE) mini-CAL	Pre- post therapy L/Co results	No correlation between changes in AAT & funct Co No sign.group difference Continuing gains for CIAT No Continuing gains for PACE Mount of pre-post change > for CIAT Confounder: severe AoS in PACE group Improvement of narrative skills MIGHT be > for CIAT Training gains similar for both groups Aphasia Severity was sign reduced in A&B Individual Analysis: sign improvement in a.l. (1)one AAT subtest (A:n=7; B:n=7; N=10)(2) one subsc. (A: n=3; B: n=2). Pat.1(B) NO improvement. MOAT sign improvements (L/Co) - Stable in F-up MOAT/CIAT plus no sign diff. in L results MOAT/CIAT sign differences in W (L) - perc/prod (Co) MOAT AAT: C (large) , TT/R/W (medium), N (small) MOAT CAL/CETI: medium to large (F-up) Naming: sign improvement-general, to untrained items Sign improvement on all subets (AAT) Aphasia Severity was sign reduced Sign improvement on naming test Behavioral gain mediated by perilesional areas Substantial improvements in comprehension (2/3) Story retell: Increase in N words and N utterances (2/3) No subj. Impovements on mini-CAL

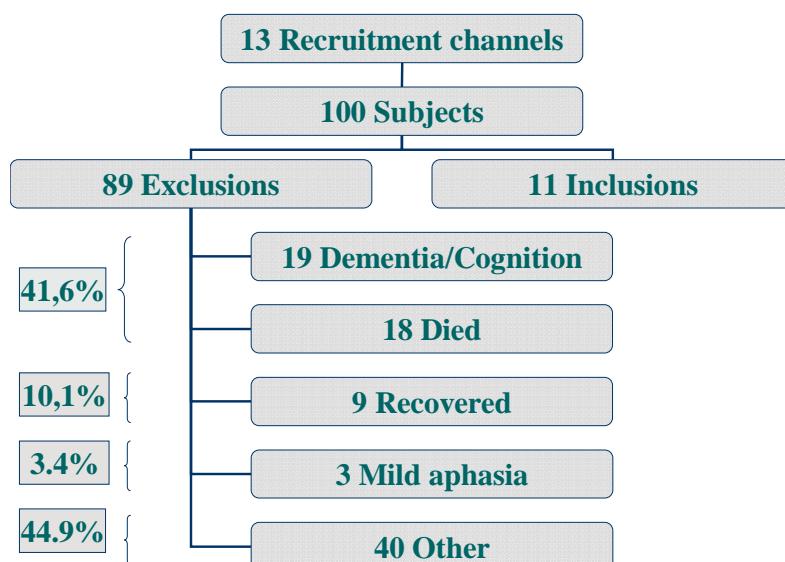
Legend
AAT=Aachen Aphasia Test
ABA=Apraxia Battery for Adults - 2
a.l.=at least
ANT=Action Naming Test
AoS=Apraxia of Speech
AQ=Aphasia Quotient
BDAE=Boston Diagnostic Aphasia Examination
BNT=Boston Naming Test
C=Comprehension
CAL=Communicative Activity Log
CAT=Conventional Aphasia Therapy
CETI=Communicative Effectiveness Index
ChA=Chronic Aphasia
CIAT=Constrained Induced Aphasia Therapy
CIAT/A - CIAT/B=CIAT by therapists/CIAT
CIAT-plus =Including written materials and photographs of everyday situations and a training module including a patients relative in daily individual communication exercises
CILT=Constraint Induced Language Therapy

Co=Communication
CT=Clinical Trial
fMRI=Functional Magnetic Resonance Imaging
I/H=Ischemic/Hemorrhagic
L=Language
LHe/Rhe=Left/Right Hemispheric
MEG=Magnetic Encephalogram
MOAT=Model Orientated Aphasia Therapy
N=Naming
NR=Not Reported
PACE =Promoting Aphasic Communicative Effectiveness
R=Repeating
RH/LH=Right/Left Handed
RCPM=Raven Coloured Progressive Matrices
SL=Speech & Language
TT=Tokentest
W=Written language
w=weeks
WAB=Western Aphasia Battery
wd=weekdays
y=year(s)

Recruitment and Sample Characteristics

A total of 89 patients (mean age 75.6, SD \pm 10.8, range 46 to 93 years) from a cohort of 100 potential participants were excluded from our study (Figure 3). Of the fluent aphasia patients 51,7% (n=46) were excluded from the study because 19 patients had developed dementia or presented with severe cognitive deficits, 18 patients died and nine had totally recovered from aphasia. The remaining 44.9 % (n=40) of the patients were excluded because of (1) out of reach (n=17) (2) refusal to participation (n=2), (3) medical complications (n=3), (4) personal or social reasons (n=3), (5) age above 90 years (n=3) and (6) other reasons of exclusion, namely bilingual, trauma, non-fluent aphasia, severe articulation problems, multiple intracerebral lesions and still at treatment (n=12). Three patients had a mild fluent aphasia after formal language testing and were not included. Before the start of the study, two participants dropped out. One of these patients was not motivated to participate and the other patient could not participate for medical reasons.

Figure 3 Patient flow in the in- and exclusion procedure of vascular chronic fluent aphasia



A total of nine participants (mean age 66.8 years SD \pm 9.2 years, range 54 to 81 years) suffering from chronic vascular fluent aphasia (mean duration 56.9 months, SD \pm 37.7 months, range 17 to 100 months), who fulfilled the inclusion criteria entered our study. Demographic and neurological data of these participants are presented in Table 3.

Aphasia resulted from a left hemisphere ischemic stroke in seven patients and from hemorrhage in two patients. In addition to the aphasigenic lesion in the left temporo-parietal region, CT scan of the brain in patient B4 disclosed a small cystic lesion in the right parietal lobe with slight attraction of the lateral ventricle. Aphasia symptoms in this patient, however, occurred simultaneously with the left temporo-

parietal infarction. Careful inquiry of the patient's medical history revealed that structural damage in the right parietal region did not result in clinically relevant symptoms and formally ruled out the aphasigenic nature of this old lesion.

Severity of the aphasic symptoms was classified as moderate in all participants ($n=9$) according to the Stanine-norms on the Token Test (TT) of the AAT. Six patients were diagnosed with Wernicke aphasia. The aphasia profile of the other three patients was consistent with a diagnosis of transcortical (TC) sensory aphasia. Following a random procedure 5 participants were allocated to the CIAT group, (3 women and 2 men), and 4 participants (men) in the BOX group. Groups did not significantly differ in age ($t_7 = -1.4$, $p=0.214$), duration of aphasia ($t_7 = 0.4$, $p=0.728$) and education ($t_7 = -0.7$, $p=0.621$).

Table 3 Demographic and neurological data

	Treatment Group	Age (years)	Sex	Handedness	Education (years)	Duration of Aphasia (months)	Etiology	Lesion site	Classification of aphasia	Severity of aphasia pretest
Case	C1	CIAT	73	F	R	8	17	I	TC sensory	Moderate
	C2	CIAT	65	F	R	12	70	I	Wernicke	Moderate
	C3	CIAT	69	F	R	15	25	H	TC sensory	Moderate
	C4	CIAT	55	M	L	15	138	I	Wernicke	Moderate
	C5	CIAT	54	M	R	17	56	I	Wernicke	Moderate
	Mean (SD)		63 (8)		12 (6)		61 (48)			
	B1	BOX	60	M	R	13	61	H	Wernicke	Moderate
	B2	BOX	76	M	R	12	26	I	Wernicke	Moderate
	B3	BOX	81	M	R	15	82	I	TC sensory	Moderate
	B4	BOX	68	M	R	12	37	I	Wernicke	Moderate
	Mean (SD)		71(9)		13 (1)		52 (25)			

Legend: CIAT (C), BOX; (B); Standard Deviation (SD); female, (F) male, (M) right (R), left (L), ischemic (I), hemorrhagic (H), transcortical (TC)

Verbal Communication Test Performance

Table 4 shows the results on the ANELT test and change in scores pre and post therapy for all cases in both treatment groups ($n=9$). Six of the nine subjects show a critical change of seven raw scores. The mean difference in scores on the ANELT for the total sample ($n=9$, $7.11 \text{ SD } \pm 3.55$) improved significantly ($t_8 = 6.0$, $p < 0.001$). The boundaries of the 95% confidence interval (CI) were 4.38 and 9.84.

The severity of the verbal communication deficit changed from moderate (mean score 33.78) to mild (mean score 40.89).

Table 4 Results of the verbal communication test, mean score and change in scores pre- and post therapy

Case	C1	ANELT ^{pre}	ANELT ^{post}	ANELT ^{Diff}
		(max 50)	(max 50)	
		M (SD)	M (SD)	M (SD)
		33.78 (5.14)	40.89 (5.25)	7.11 (3.55)
Case	C1	41	45	4
	C2	35	46	11
	C3	38	39	1
	C4	32	40	8
	C5	40	47	7
	B1	29	37	8
	B2	33	42	9
	B3	30	42	12
	B4	26	30	4

Legend: M=Mean, SD=Standard Deviation, C=CIAT, B=BOX,
Shaded scores indicate meaningful change of 7 raw scores as defined by ANELT

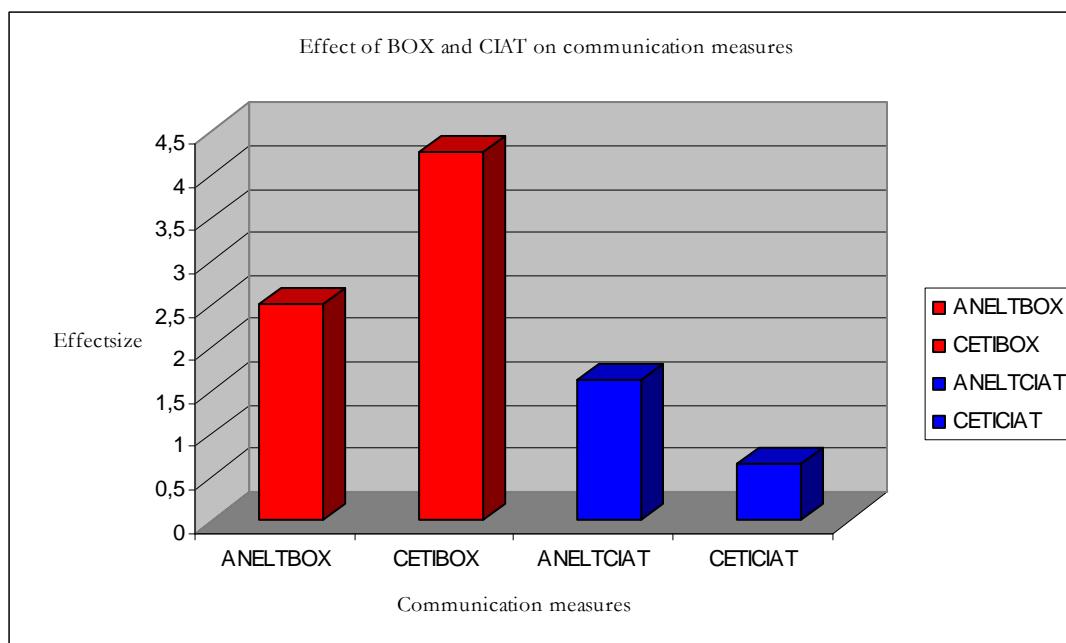
Mean improvement on verbal communication tended to be smaller in the CIAT group than in the BOX group (Table 5).

Table 5 Comparison of the mean final score and mean improvement on the ANELT test for both treatment groups (n=9)

	CIAT (n=5)	BOX (n=4)	Mean Difference (95% CI)
Mean final score (SD)	43,40 (3.65)	37,75 (5.68)	5,65 (-1.69-12.99)
Mean improvement (SD)	6,20 (3.83)	8,25 (3.30)	-2,43 (-7.79-3.69)

* statistically significant improvement or difference

This tendency was supported by an effect size of $d=2.5$ for the BOX group and an effect size of $d=1.62$ for the CIAT group (Figure 4). The 95% CIs of the CIAT group and the BOX group were between 1.44 – 10.96 and 2.99 – 13.51 respectively. However, no statistically significant difference between the treatment groups was found when the mean improvement was compared ($t_7 = -0.9, p=0.426$).

Figure 4 Treatment effects on verbal communication measures

Legend : Amsterdam Nijmegen Everyday Language Test (ANELT); Communicative Effectiveness Index (CETI)

The effectiveness of verbal communication in every day life was assessed by means of a Dutch translation of the CETI. The relatives considered the effectiveness of communication as significantly improved after treatment (mean improvement 11.76, SD \pm 11.03; $t_7 = 3.0$, $p=0.019$, 95% CI 2.54 – 20.98). No statistically significant difference in mean improvement after training was found between CIAT and BOX therapy ($t_6 = -1.1$, $p=0.332$). However, with regard to the effect size, we found a large effect ($d=4.27$) after BOX treatment and a medium sized effect ($d=0.66$) after CIAT training (Figure 4).

Semantic and Phonological Test Performance

Semantic Measures

Table 6 illustrates the mean progress of both CIAT and BOX on semantic measures and the mean difference in progress between CIAT and BOX. All patients ($n=4$) treated with BOX demonstrated a significant change on the SWALI test when pre and post test results were compared ($t_3 = -9.0$, $p=0.003$, $d=4.5$, Table 6). Although no statistically change in mean improvement was found on the ASJ task in the BOX group ($t_3 = -2.8$, $p=0.071$, $d=1.37$), a critical mean improvement of 4.25 raw scores was obtained after treatment (Table 6). In contrast, no significant improvement on the SWALI ($t_4 = -0.67$, $p=0.541$, $d=0.30$) and the ASJ ($t_4 = -0.30$, $p=0.778$, $d=0.14$) was found after CIAT training ($n=5$). Performances

on the VSAT did not significantly change in the CIAT ($t_4 = -0.95$, $p=0.395$, $d=0.43$) and BOX group ($t_3 = -1.58$, $p=0.213$, $d= 0.79$).

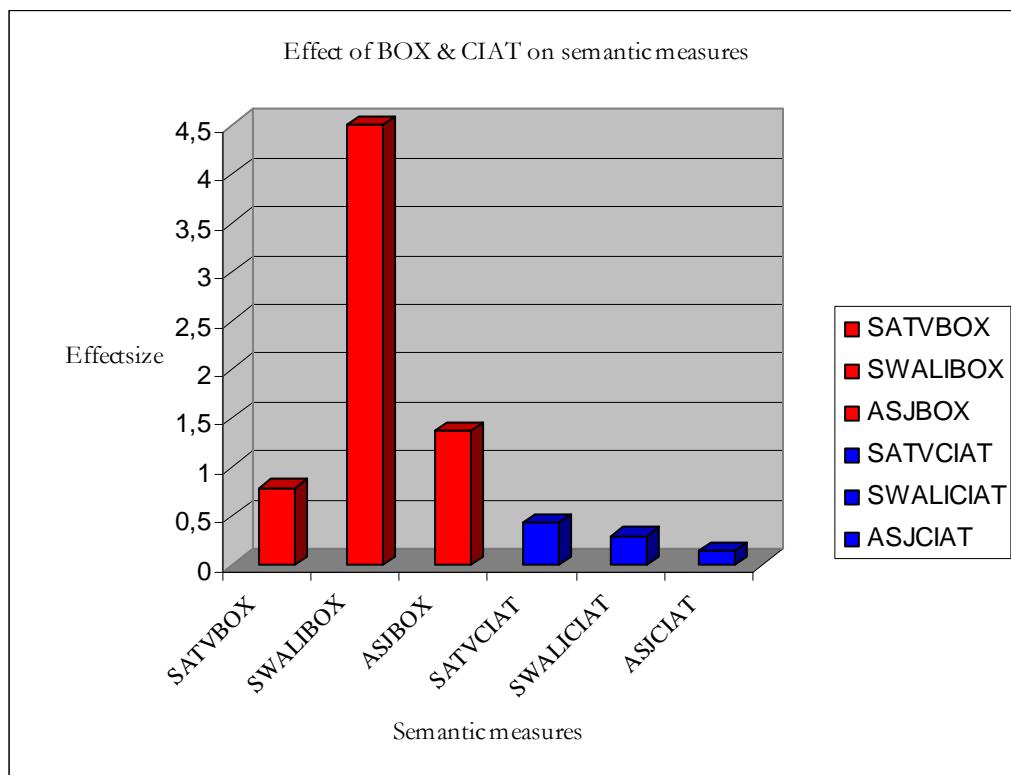
Table 6 Mean progress of both treatment groups, and mean difference in progress between treatment groups on semantic measures

	Treatment Group	N	Mean improvement (SD)	Mean difference between treatment groups (95% CI)
SATvisual (max=30)	CIAT	5	0,0 (1.22)	0.5 (-2,50)
	BOX	4	-0,5 (2.52)	
VSAT (max=30)	CIAT	5	2,2 (5.17)	0.45 (-6.16,7.06)
	BOX	4	1,75 (2.22)	
SWALI (max=15)	CIAT	5	0,4 (1.34)	-1.85 (-3.54,-0.16)*
	BOX	4	2,25 (0.50)*	
ASJ (max=60)	CIAT	5	0,2 (1.48)	-4.05 (-8.68,0.58)*
	BOX	4	4,25 (3.10)	

Legend: Visual Semantic Association Test (SATvisual); Verbal SAT (VSAT); Semantic Word Association of Low Imageability (SWALI); Auditory Synonym Judgement (ASJ); Standard Deviation (SD); 95% Confidence Interval (CI); * statistically significant improvement or difference ($\alpha= 0.05$); Note: Shaded areas indicate a clinically significant improvement using a change in score of $\geq 2\text{SD}$ from the mean normal performance on the Semantic Word Association for low imageability words (≥ 2 points) and on the Auditory Synonym Judgment (≥ 3 points).

However, the effect sizes on the three semantic measures (SWALI, ASJ, VSAT) tended to be large for the BOX group and small for the CIAT group (Figure 5). The results on the visual SAT did not change in both treatment groups ($n=9$) and no treatment effects were found [CIAT: $t_4 = 0.0$, $p=1$, $d=0$; BOX: $t_3 = -0.4$, $p=0.718$, $d=-0.199$]. The mean difference in progress between the two groups was statistically significant for the SWALI task ($t_5 = -2.8$, $p=0.034$) and the ASJ task ($t_7 = -2.6$, $p=0.035$).

Analysis of the individual case data (Appendix 7), demonstrates that only one (C4) of the five CIAT participants showed a change in scores of two or more SD on semantic measures. In contrast, four participants of the BOX group (B1, B2, B3, B4) showed critical gains in raw scores on the SWALI task. Moreover, three BOX participants significantly improved on the ASJ test. However, no participants from both treatment groups ($n=9$) obtained critical changes on the VSAT.

Figure 5 Treatment effects on semantic measures

Legend: SATV: Verbal Semantic Association Test; SWALI: Semantic Word Association of Low Imageability; ASJ: Auditory Synonym Judgement

Phonological Measures

Mean improvement on phonological measures was not statistically significant in the CIAT group (NR, $t_4 = 1.7$, $p=0.172$, $d=0.74$; ALD, $t_4 = 1.5$, $p=0.198$, $d= 0.69$) and the BOX group (NR, $t_3 = 0.6$, $p=0.604$, $d=0.29$; ALD, $t_3 = 0.7$, $p=0.512$, $d=0.37$). The mean progress of both treatments and the mean difference between both therapeutic interventions is presented in Table 7. Effect sizes on phonological measures were medium within the CIAT group and small in the BOX group (Figure 6). The shaded area indicates a critical mean change of 5 points or more (≥ 2 SD from normal performance) on the lexical decision task for the CIAT participants (Table 7). No significant difference between the treatment groups was found when the mean improvements on the phonological measures were compared (NR, $t_7 = 1.1$, $p>0.05$; ALD, $t_7 = 0.7$, $p>0.05$).

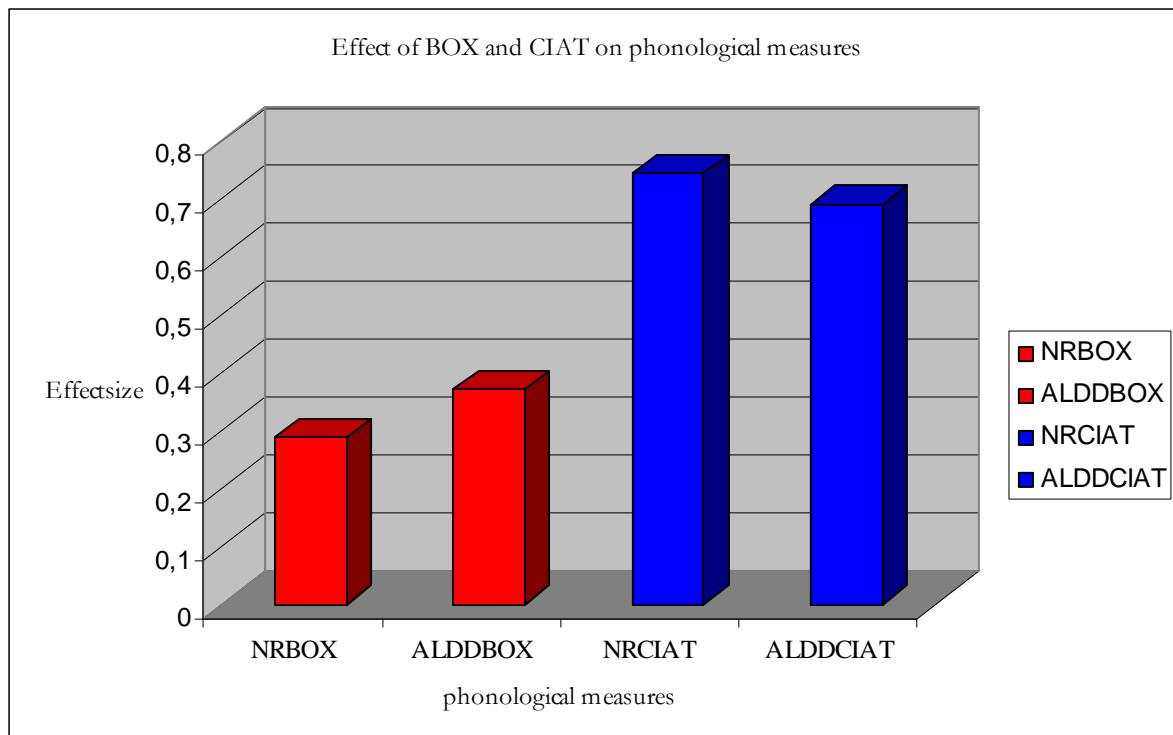
Table 7 Mean progress of both treatment groups, and mean difference in progress between treatment groups on phonological measures

	Treatment Group	N	Mean improvement (SD)	Mean Difference between treatment groups (95% CI)
NR (max 30)	CIAT	4	2.75 (4.35)	2.25 (-3.48,7.98)
	BOX	4	0.5 (1.73)	
ALD (max 160)	CIAT	5	6.8 (9.89)	4.05 (-10.06, 18,16)
	BOX	4	2.75 (7.41)	

* statistically significant improvement or difference ($\alpha = 0.05$)

Legend: Nonword Repetition (NR), Auditory Lexical Decision (ALD), Standard Deviation (SD), Confidence Interval (CI); Note: Shaded area indicates a critical change in raw scores using a change in score of $\geq 2\text{SD}$ from the mean normal performance on the ALD (≥ 5 points).

Two of the five CIAT participants (C2, C4) demonstrated critical changes on phonological measures (Appendix 7). The two BOX participants obtained a critical improvement in raw scores on the ALD task.

Figure 6: Treatment effects on phonological measures

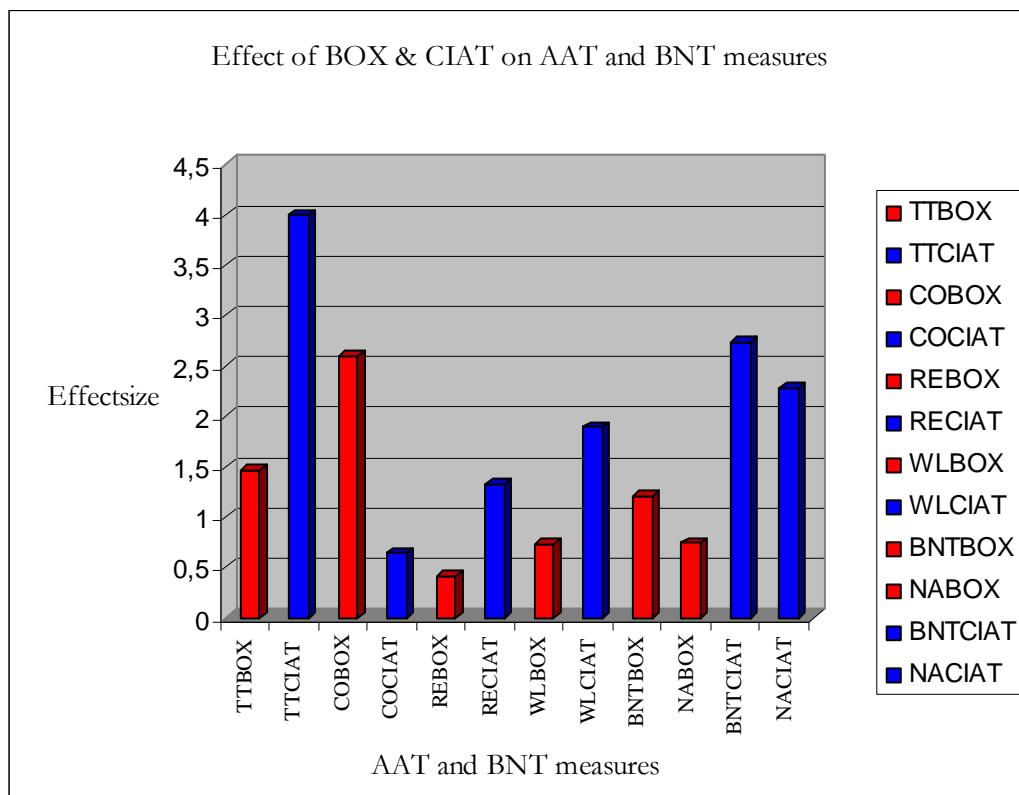
Legend: Nonword Repetition (NR), Auditory Lexical Decision (ALD)

Formal Language Test Performance

Changes in AAT scores were found. All participants ($n=9$) obtained a critical change in raw scores as defined by the AAT, on at least one of the AAT subtests or subscales (Appendix 8, 9). Seven of the nine participants (all CIAT participants ($n=5$) and 2 BOX participants (B1, B2) improved significantly on the Token Test (Appendix 8). Five of these seven participants evolved from moderate to mild aphasia. Two BOX participants (B1, B4) showed a critical change in scores on the naming subtest (Appendix 8). No critical improvements were found on comprehension, repetition and written language subtests of the AAT. However, except for two participants (C2, B2) all participants showed critical changes on one of the naming subscales (Appendix 9). The near general progress on naming tasks was also reflected by the critical change in scores found in eight of the nine participants (C1, C2, C3, C4, C5, B1, B3, B4) on the BNT (Appendix 8). Two CIAT participants (C3,C4) improved significantly on one or two of the repetition subscales (Appendix 9). Two participants (C5, B4) showed critical improvement on the third subscale of written language (Appendix 9).

Analysis of variance (GLM repeated measures procedure of SPSS) was carried out on these data obtained in our two-factorial split-plot design. There was one between-subject factor GROUP with two levels, namely CIAT and BOX, and one within-subject factor TIME, namely pre and post treatment. Both groups showed significant changes pre and post therapy on the five subitems of the AAT and the BNT (within subject effects, Huynh-feldt adjusted): (1) TT ($F_{(1,7)} = 55.54$, $p < 0.001$), (2) CO ($F_{(1,7)} = 15.84$, $p < 0.05$), (3) NA ($F_{(1,7)} = 7.53$, $p < 0.05$), (4) RE ($F_{(1,7)} = 7.04$, $p < 0.05$), (5) WL ($F_{(1,7)} = 7.99$, $p < 0.05$) and (6) BNT ($F_{(1,7)} = 22.53$, $p < 0.05$). However, there was no significant group by time interaction and no effect of treatment group for: (1) TT results ($F_{(1,7)} = 0.039$, $p = 0.848$), (2) CO ($F_{(1,7)} = 1.236$, $p = 0.303$), (3) NA ($F_{(1,7)} = 0.850$, $p = 0.387$), (4) RE ($F_{(1,7)} = 0.028$, $p = 0.872$), (5) WL ($F_{(1,7)} = 0.001$, $p = 0.981$) and (6) BNT ($F_{(1,7)} = 0.004$, $p = 0.953$).

Figure 7 demonstrates the difference in effect sizes on formal language measures between CIAT and BOX treatment. CIAT was associated with large effects sizes on three of the four AAT language subtests, which as RE ($d = 1.33$), on NA ($d = 2.28$) and on WL ($d = 1.897$). The effect on CO was medium sized ($d = 0.64$). In contrast, the BOX treatment reached small to medium sized effects on RE ($d = 0.413$), NA ($d = 0.741$) and WL ($d = 0.732$), but obtained a large effect size ($d = 2.59$) on the CO task. Both treatments revealed large effects on the TT [$d = 4.0$ (CIAT) to 1.47 (BOX)] and on the BNT [$d = 2.74$ (CIAT) to 1.21 (BOX)].

Figure 7 Treatment effects on formal language measures

Legend: Tokentest (TT); Comprehension (CO); Repetition (RE); Written Language (WL); Naming (NA); Boston Naming Test (BNT).

Well-being measure

Table 8 shows the mean rating score of eight out of the nine participants on the six items of the well-finding seven point scale (0 = not agree; 7 = strongly agree, Appendix 6). All participants were satisfied (total mean score 37.0/42, SD \pm 6.1) and would participate a second time (item 2, mean score 6.1, SD \pm 1.4). Patients unanimously and strongly considered the high intensity of the treatment realistic (item 4, mean score 7.0 points, SD \pm 0.0).

All participants preferred a short period of highly intensive treatment over a treatment spread over a long period of time (item 6, mean score 6.3, SD \pm 1.5). Although the BOX participants scored on all items (except on item six) slightly higher than the CIAT participants, no statistically significant differences between both treatment groups were found when mean scores were compared ($t_6 = -1.7$ to 0.5, $p=0.816$ to 0.194).

Table 8 Well-being measures

	Treatment Group	N	Mean score (SD)
Well Finding total score	CIAT	4	35.0 (8.5)
(Max 42)	BOX	4	39.0 (0.8)
	CIAT/BOX	8	37.0 (6.1)
1.Participation	CIAT	4	5.6 (1.5)
(Max 7)	BOX	4	7.0 (0.0)
	CIAT/BOX	8	6.4 (1.2)
2.Second Participation	CIAT	4	6.0 (1.4)
(Max 7)	BOX	4	6.3 (1.5)
	CIAT/BOX	8	6.1 (1.4)
3.Communication	CIAT	4	5.3 (2.1)
(Max 7)	BOX	4	5.8 (1.5)
	CIAT/BOX	8	5.5 (1.7)
4.Intensity	CIAT	3	7.0 (0.0)
(Max 7)	BOX	4	7.0 (0.0)
	CIAT/BOX	7	7.0 (0.0)
5.Pleasure	CIAT	4	6.3 (1.5)
(Max 7)	BOX	4	7.0 (0.0)
	CIAT/BOX	8	6.6 (1.1)
6.Short vs Spread treatment	CIAT	4	6.5 (1.0)
(Max 7)	BOX	4	6.0 (2.0)
	CIAT/BOX	8	6.3 (1.5)

Legend: Standard Deviation (SD), Maximum (Max), Versus (vs)

Discussion

Reviewing a cohort of 69 patients with chronic aphasia published in the CIAT literature since 2001 we found that: 1) CIAT treatment effects have only been studied in a semiologically heterogeneous population of patients with predominantly non-fluent aphasia types ($n=37$; 53.6%) and 2) patients with mild ($n=22$, 31.9 %) and severe ($n=11$, 15.9%) aphasia are underrepresented in the study population and 3) patients were relatively young in age (mean age 53.3 years, $SD \pm 12.6$ years). Our observations partially replicate the findings of a recent evidence-based review of Cherney et al. (2008) on the effect of intensity of treatment and on CIAT. These authors also demonstrated that the majority of the participants had non-fluent aphasia (60,0%; 42/70), typically defined as Broca aphasia. In addition, Cherney et al. (2008) stated: "...Most had moderate aphasia (48%, 30 of 62) whereas 19 participants (31%) had mild aphasia and 12 participants (19%) had severe aphasia...".

From a methodological point of view the distribution of fluent/non-fluent aphasia patients included in the CIAT studies should for reasons of unselect recruitment match with the distribution of the fluent/non-fluent dichotomy in the general population of vascular aphasia patients. Castro-Caldas & Confraria (1984) demonstrated in a cohort of 390 patients with left hemispheric vascular aphasia that the non-fluent-fluent aphasia dichotomy respectively represents 70,8% and 19,5% of the population. The remaining 9,7% consisted of transcortical aphasia types which were not specified in fluent or non-fluent subtypes. These authors not reported the time post onset in their study population. In contrast, following the natural course of aphasia in an unselective, consecutive sample of aphasia patients with acute stroke, two studies included in the chronic stage of recovery (i.e. 12 months post onset) more patients with fluent aphasia ($n=50$) than non-fluent aphasia ($n=22$) (Kauhanen et al., 2000; Pedersen et al., 2004). Pedersen et al. (2004) included 18 (35,3%) non-fluent aphasia patients (i.e. global aphasia, Broca aphasia and transcortical motor aphasia) and 33 (64,7%) fluent aphasia patients (i.e. Wernicke-aphasia, conduction aphasia, transcortical sensory aphasia and anomic aphasia). Kauhanen et al. (2000) included 4 (19,1%) non-fluent patients and 17 (80,9%) fluent patients. Laska et al. (2001) also showed in an unselected sample of aphasia patients in the acute stage of recovery a higher proportion of fluent than non-fluent aphasia patients, respectively consisting of 77 (65,8%) and 40 (34,2%) patients. After 18 months of recovery, no exact number of patients was reported but the fluent group still outnumbered the non-fluent group. With respect to the non-fluent-fluent dichotomy, it seems that different recruitment procedures have led to conflicting results. Extent of the study corpus might have been a factor as well. Laska et al. (2001) argued that the higher proportion of fluent aphasia might be due to the high age of the study population (i.e. 78,6 years). In the study of Pedersen et al. (2004) the mean age of the aphasia patients is 75,5 ($\pm 9,2$) years which can explain the higher prevalence of fluent-aphasia in this population. The mean age of the aphasia patients was not reported in the study by Kauhanen et al. (2000). Castro-Caldas & Confraria (1984) reported a mean age of 57,4 years (median 59) in their study population, which is comparable with the relatively young mean age of the aphasia patients in the CIAT literature. Thus, the relatively young mean age of the aphasia patients might explain overrepresentation of Broca aphasics in the

CIAT studies. Previous studies confirmed that individuals with non-fluent aphasia tended to be significantly younger than those with fluent aphasia (e.g. Bhatnagar et al., 2002; Eslinger & Damasio, 1981; Ferro & Madureira, 1997; Kertesz & Sheppard, 1981; Obler & Albert, 1981; Pedersen et al., 2004; Steinvil et al., 1985). Bhatnagar et al. (2002, p354) stated that: "...With little variation, the general age range for subjects with Broca's aphasia is between 40 and 50, while the incidence of Wernicke's aphasia steadily increases with age peaking around 70...". Moreover, some authors found that non-fluent aphasia patients had more severe aphasia than fluent patients (Pedersen et al., 2004; Taylor-Sarno, 1992). However, statistical analysis disclosed neither a significant trend in age and aphasia type nor a trend in severity and fluency in the reviewed cohort of 69 CIAT patients. The mean-age of the nine participants in our study was 66.8 years ($SD \pm 9.2$ years), which was more than 10 years above the mean age of the 69 cases in the CIAT studies (i.e. 53.3 years). The higher age in this sample might be due to the presence of exclusively fluent patients which seems to confirm the findings of previous studies that fluent aphasia patients tend to be older than non-fluent patients.

As a result of the limited generalizability of the CIAT findings in a fluent aphasia population, we for the first time investigated in this study the outcome of a functional (CIAT) and a cognitive linguistic treatment method (BOX) in a homogeneous group of nine chronic fluent vascular aphasia patients. Severity was controlled. All patients had moderate aphasia as defined by means of the Stanine-norms on the Token Test of the AAT. Although no robust conclusions can be drawn from the relatively small sample size, our study results demonstrate that patients with fluent aphasia significantly benefit from highly intensive CIAT or BOX treatment in the chronic stage of recovery. Treatment effects were not limited to significant changes in language skills as measured by formal language tests (AAT and BNT). Verbal communication skills also improved as reflected by significantly increased results on the ANELT scale and on the CETI questionnaires that were completed by the relatives of the patients.

The short-term effectiveness of the highly intensive practice of CIAT has also been studied in a predominantly non-fluent chronic aphasia population (Maher et al., 2006; Meinzer et al., 2005, 2007, 2008; Pulvermüller et al. 2001, Szaflarski et al., 2008). Meinzer et al. (2005) in addition showed long-term stability (i.e. after 6 months) of improved language function in chronic aphasia following a treatment with CIAT, irrespectively of age, time post stroke and severity. Twenty-seven patients with chronic aphasia were randomly assigned in groups of 2 or 3 to either the CIAT group or the CIAT plus group. CIAT plus is an extension of the original CIAT therapy in which written materials and photographs of everyday situations are included. In addition, the CIAT plus procedure requires a relative of the patient to train communication on an individual basis. All patients received 30 hours of treatment over a 2-week period (i.e. 3 hours per day). No significant differences in outcome after therapy and during follow-up were found between both treatment groups. Significant improvement was confirmed for the AAT profile in both time periods. A total of 85% of the patients improved after therapy on at least one AAT subtest or one subscale. Patients and relatives of both groups consistently reported an increase of quality and amount of communication in everyday life immediately after therapy as assessed by the CETI and the 'Communicative Activity Log (CAL)' (Pulvermüller et al., 2001), which are both questionnaires assessing

the quality and quantity of everyday communication. However, this increase in verbal communication was more pronounced and lasting in those patients who received additional training in daily communication from patient's relatives (CIAT-plus). Although Meinzer et al. (2005) did not discuss which aspect of CIAT (constraint, shaping, intensity or combination) induced the improvement of language skills, these authors clearly suggested that any intervention in the chronic stage of aphasia may profit from a treatment with a massed schedule.

With regard to the aspect of massed practice, beneficial short and long-term effects of other aphasia therapies, such as the 'Promoting Aphasic Communicative Effectiveness (PACE)' therapy (Davis and Wilcox, 1985) and 'model-orientated aphasia therapy (MOAT)', have been shown as well in a chronic non-fluent aphasia population (Barthel et al., 2008; Maher et al., 2006). Barthel et al. (2008) aimed to evaluate which factors contribute to the success of aphasia therapy (i.e. intensity, shaping, group setting, constraint induced, specific and individual approach, written language, every day training and involvement of relatives). They compared short and long-term (i.e. 6 months post treatment) therapy outcomes of 12 patients who received MOAT with the earlier reported language and verbal communication results of the 27 patients who received either CIAT or CIAT plus in the study by Meinzer et al. (2005). The MOAT was applied in the same intensive training schedule. MOAT employs an individual setting and offers the patients an individual approach based on their symptoms. In MOAT, the model-oriented treatment approach is combined with the linguistic approach, the strategy approach, the communicative approach and the involvement of relatives (Barthel et al., 2008). MOAT contrasts with CIAT regarding the constraint-induced aspect and the group setting. Barthel et al. (2008) showed substantial improvement of language function in 11 of 12 chronic aphasia patient following intensive treatment with intensive MOAT. The improvements remained stable during a follow-up period of 6 months. Results were comparable to those of CIAT for almost all variables, except for writing and everyday communication. MOAT led to more improvement than CIAT whereas MOAT and CIAT plus did not differ. Barthel et al. (2008) emphasized that training effects were best achieved by specific and intensive training. Only Maher et al. (2006) could not show the consistency of language improvements after a highly intensive practice of PACE therapy. PACE therapy is also a functional communication therapy and only differs from the CIAT in the dimension of language constraint. This means that all modes of communication are allowed in the PACE treatment. Maher et al. (2006) compared the pre and post treatment language results of the CIAT and the PACE therapy in a clinical trial with nine chronic aphasia patients (type not specified). Only the CIAT demonstrated long term stability as compared with a highly intensive PACE therapy suggesting the presence of another aspect of the CI approach that leads to additional benefit, namely the constraint principle. Maher et al. (2006) did not evaluate the therapeutic gains regarding the verbal communication abilities of the patients. With regard to the long-term stability of the highly intensive treatments, Maher et al. (2006) showed the importance to include a follow up of the treatment results in their study. Therefore, we planned a follow-up of the CIAT and BOX treatment results within six months post therapy.

Summing-up, study results obtained in a predominantly non-fluent aphasia population clearly suggest that (1) regardless of the type of treatment aphasia patients benefit from a short-term highly intensive

practice, (2) aphasia patients show lasting benefits after massed practice of function (3) besides intensity, the type of training seems to be an important factor in aphasia therapy and (4) specific training leads to more pronounced improvements on communication measures.

In addition to substantial improvement in language functioning and verbal communication skills after CIAT or BOX treatment, the BOX treatment induced additional training effects on the semantic level and showed more pronounced improvements on verbal communication measures. As expected, the treatment with BOX significantly influenced semantic but not phonological performances. In contrast, CIAT resulted in no statistically significant improvements on the semantic level and effect sizes were small. Consequently, both treatments showed a statistically significant difference in mean improvement on semantic measures. In agreement with the findings of previous studies (Doesborgh et al., 2004; Visch-Brink, 1997), the pure semantic training with BOX only influenced semantic performances and did not have benefits on the phonological level. With regard to the phonological measures results showed neither a statistically significant mean improvement within the treatment groups nor a significant difference in mean improvement between both treatments after intensive treatment with CIAT or BOX. However, the effect size within the CIAT group was medium sized whereas the effect size within the BOX group was small. It seems that the overall improvement on phonological measures might have been stronger for the CIAT group although no significant improvement was obtained.

The results of our study corroborate with the findings in previous CIAT studies that besides intensity the type of therapy is a crucial factor in therapeutic outcome. In-depth linguistic analyses at the impaired linguistic level (lexical semantics, phonology) for the first time allowed to control the linguistic improvements across verbal communication functioning after an intensive CIAT training. Furthermore, only additional linguistic analysis that investigates specific linguistic skills was sensitive enough to detect specific training effects. As Raymer et al. (2008, p.S268) stated: "...Yet to be determined is the influence of treatment intensity across different domains of language or dependent variable. Future research needs to examine the relative effect of treatment intensities on behaviours that span domains of language and communication (e.g. semantics, phonology, orthography, morphosyntax, pragmatics/discourse/social)...". In the light of this statement, the question remains whether a specific treatment (CIAT or BOX) delivered under different conditions (i.e. varying the intensity schedule, the quantity (repetition), the sequence of treatments, aphasia population or linguistic impairments, severity of aphasia, the complexity of the tasks, involving relatives) still yields positive outcomes. The interference between functional communication therapy, impairment based therapy and the impact of language therapy in every day life across all different dependent variables needs further investigation in order to determine the most optimal treatment for aphasia patients and their environment.

Conclusion

Summing-up, our explorative study on the treatment effects of CIAT and BOX in a small cohort of stroke patients with moderately impaired chronic fluent aphasia with combined semantic and phonological deficits shows that:

- 1 intensive treatment has a significant short-term effect on language and communication in patients with chronic fluent aphasia irrespectively of the type of language therapy used.
- 2 a highly intensive semantic training (BOX) results in selective training effects and a more pronounced improvement of verbal communication performance when compared with a CIAT training in the same population
3. the specificity of training in a short period of time might be another important aspect in understanding the effectiveness of high intensive language therapy.

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Links

- <http://www.imagesymbols.com/>
- <http://crl.ucsd.edu/~aszekely/ipnp/1database.html>

Appendix 1

Dutch manual of the CIAT

“Constraint Induced Aphasia Therapy” (CIAT): Therapeutische Richtlijnen

Ineke Wilssens – AGW Logopediewetenschappen – Universiteit Utrecht – Februari 2009

1. “Constraint” van Non-Verbale Communicatie & Setting

Groep van min. 2 en max. 3 patiënten in het bijzijn 1 of 2 therapeuten. Door het plaatsen van schermen tussen de patiënten verhindert men dat de patiënten elkaar kunnen zien (Pulvermüller F, Neininger B, Elbert T, Mohr B, Rockstroh B, Koebbel P and Taub E, 2001). De patiënten hebben wel oogcontact. Op deze manier wordt de non-verbale communicatie via gebaren, aanwijzen of “finger writing” onderdrukt (constraint). Hoewel het onderdrukken van de non-verbale communicatie één van de drie principes van CIAT vormt, kunnen patiënten wel gebaren of aanwijzingen gebruiken wanneer dit de mondelinge communicatie ondersteunt en het dus niet de verbale communicatie vervangt (Meinzer M, Djundja D, Barthel G, Elbert T and Rockstroh B, 2005).

Figuur 1 illustreert de opstelling.



Figuur 1 CIAT setting in het ZNA Middelheim

2. Procedure

(Volgens Pulvermüller et al., 2001; Maher L, Kendall D, Swearengin, J, Rodriguez A, Leon S, Pingel K, Holland A and Rothi L, 2006; Meinzer et al., 2005 en Meinzer M, Streiftau S and Rockstroh B, 2007)

Algemene Procedure

Het spel wordt gespeeld met een set van 32 kaarten (=16 paar identieke kaarten), per 45 min., gevolgd door 10 tot 15 min. pauze. De totale sessieduur bedraagt drie uur. De totale termijn is 10 opeenvolgende weekdagen. De patiënten krijgen de opdracht om telkens één kaart uit de door de

(Appendix 1)**Dutch manual of the CIAT**

therapeut bedeedde kaarten ($n= 4/6$ per ronde) te kiezen. Zonder de kaart aan de medespelers te tonen, zal de “vrager” één van de medespelers explicet aanspreken en de kaart met het door hem gekozen object vragen. De aangesproken medespeler wordt gevraagd om de gevraagde kaart aan de “vrager” te overhandigen indien hij/zij de kaart bezit. Indien de “gevraagde” de gevraagde kaart niet bezit, dient hij/zij explicet de vraag te beantwoorden. Wanneer de “gevraagde” de kaart niet bezit, neemt de “vrager” een nieuwe kaart. Het doel is om zoveel mogelijk gepaarde kaarten te verzamelen. Alle communicatie dient dus via gesproken woorden of zinnen te verlopen. Het is aan de therapeut om elke patiënt op het niveau te laten oefenen dat niet frustrerend is maar dat de patiënt wel uitdaagt. “Constraints” worden geïntroduceerd om de patiënten tot het gebruik van gesproken communicatie te forceren. Deze “constraints” beschouwen we langs drie dimensies: (1) materiaal ‘constraints’, (2) shaping en spelregel ‘constraints’ en (3) bekrachtigingen van ‘constraints’.

Materiaal ‘constraints’

Op de kaarten worden zowel hoog- als midden- en laagfrequente woorden afgebeeld. Bovendien kunnen de kaarten uit één set ook fonologisch verwante woorden afbeelden (bv. minimale paren als ‘muur’ en ‘vuur’). Tenslotte kunnen de kaarten beperkt worden tot zwart/witte afbeeldingen van objecten of illustraties van objecten in verschillende kleuren of aantallen. Om een meer geavanceerde verbale communicatie te induceren, kan de therapeut dus (1) afbouwen in woordfrequentie (2) objecten laten verschillen in kleur en aantal, (3) de patiënt hogere articulatorische precisie opleggen door minimale paren te gebruiken en (4) 1,2 en 3 combineren. Bijvoorbeeld: het gebruik van een kaart met een gekleurd object met de naam van een minimaal paar zoals bijvoorbeeld (witte/zwarte rok/sok). De patiënt moet het voorwerp precies articuleren en het juiste kleur adjektief toevoegen om de juiste kaart te pakken te krijgen.

Maher en haar collega’s (2006) liet de patiënten het spel ook spelen met kaarten van objecten binnen eenzelfde semantische categorie, zoals bijvoorbeeld fruit. De woorden worden ook geordend volgens woordfrequentie, namelijk hoogfrequent en laagfrequent. Meinzer et al. (2007) introduceert kaarten die situaties uit het dagelijkse leven illustreren.

(Appendix 1)

Dutch manual of the CIAT

Shaping en Spelregels ‘constraints’

Opbouwen Syntactische complexiteit

In het begin kunnen alle relevante uitingen worden gebruikt. Naarmate de therapie sessies vorderen, worden de verbale uitingen gradueel beperkt door (1) expliciete regels die de therapeut invoert en (2) shaping en modeling. Het is aan de therapeut om de mogelijkheden van de patiënten tijdens de eerste sessies goed te observeren (zie ‘specifieke taken van de therapeut’). Mogelijke regels zijn: namen van medespelers gebruiken of de toevoeging van beleefdheidsuitingen (bv. aanvankelijk enkel het object: “paard”, later de aansprekking toegevoegd “meneer Janssens, een paard aub”, nog moeilijker: “meneer Janssens, geef mij een paard aub”, of “mevrouw Spiessens, ik zou graag een kikker hebben aub?”). Bovendien kan er gevraagd worden de juiste vervoeging te gebruiken wanneer bijvoorbeeld de getallen worden geïntroduceerd (bv. “twee kikkers”). Voor meer geavanceerde patiënten worden syntactisch complexere zinnen vereist ipv één- of twee woordzinnen (bv. “meneer Janssens, kan jij mij twee kikkers geven, aub of “...heb jij voor mij twee kikkers aub?” of als antwoord “Ja, ik heb ...voor jou”/”Nee, ik heb geen...voor jou”). Wanneer een andere medespeler aan de beurt is, kunnen de patiënten zeggen: “Meneer/mevrouw..., het is jouw beurt.” Bij het aannemen/geven van een kaart wordt er steeds gezegd: “dank u meneer/mevrouw....” / “alsjeblief, meneer/mevrouw,...”. Bij patiënten met mindere verbale capaciteiten kan de expliciete aansprekking weggelaten worden.

Cueingsstrategieën

Aanvankelijk kan de therapeut zoveel mogelijk helpen (cueing) volgens de behoeften van elke patiënt om een succesvolle respons aan te moedigen. Het is aan de therapeut om dit samen met de patiënten tijdens de eerste sessie te experimenteren. Mogelijke cueingsstrategieën zijn: fonologische cue (bv. eerste letter/lettergreep, semantische cue (bv omschrijving), selectie uit een reeks woorden, naspreken, reminder/visuele aandacht (bv. als patiënt aan de vrucht “avocado denkt, kan hij het woord advocaat oproepen) en “visual oral posture cue”(mondbeeld). Volgens het shapingprincipe wordt de hulp van de therapeut gradueel verminderd.

(Appendix 1)

Dutch manual of the CIAT

Het bekraftigen van “constraints” aangepast aan de mogelijkheden van patiënt

Iemand met beperktere verbale capaciteiten ten aanzien van anderen in dezelfde groep zal reeds bekraftigd worden wanneer aan één van de op dat moment ingevoerde ‘constraints’ wordt voldaan. Iemand met hogere capaciteiten binnen diezelfde groep zal aan alle ‘constraints’ moeten voldoen. Dit type van ‘constraint’ is dus vooral van toepassing wanneer patiënten in eenzelfde groep van niveau verschillen.

3. Specifieke Taken van de Therapeut

Systematische Observatie

Om de non-verbale communicatie en de cuingsstrategieën te kunnen registreren, kan de therapeut van de eerste en laatste sessie een video-opname maken of een co-therapeut het gedrag en de hulpstrategieën laten observeren en registreren. In appendix 1 kan je een tabel vinden met de code-opties tav de non-verbale gedragingen en de mogelijke cueingsstrategieën. Op deze manier hebben we controle over het shapingprincipe.

Studenten/Vrijwilligers Training (volgens “Layperson training” door Meinzer et al., 2007)

Studenten/vrijwilligers worden vooraf duidelijk geïnstrueerd over de trainingsprocedure, het materiaal en de therapieprincipes ahv een 1 uur durende presentatie en een video-opname. Bovendien krijgen ze elk een geschreven handleiding. De eerste sessie staan de studenten/vrijwilligers onder supervisie van een ervaren therapeut. De overige sessies leiden de studenten/vrijwilligers de sessies maar kunnen steeds terugvallen op een supervisor die in het gebouw aanwezig is. Onmiddellijk aansluitend op elke sessie wordt er gevraagd om de positieve en negatieve bevindingen te briefen aan de supervisor en wordt het therapieverloop van de volgende dag vastgelegd (15 min.). Studenten/vrijwilligers kunnen rekenen op continue feedback van de supervisoren zodat de supervisoren een heldere kijk hebben op het therapieverloop.

(Appendix 1)**Dutch manual of the CIAT****Referenties**

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(Appendix 1)**Dutch manual of the CIAT****Appendix 1**

Naam/Datum		
NVG	Sessie 1	Sessie 10
G		
W		
S		
VS		

Legende

G = gebaar
 W = wijzen
 S = schrijven
 VS = vingerschrijven

Naam/Datum		
Cueing	Sessie 1	Sessie 10
F		
S		
N		
Sel		
R		
MB		

Legende

F = fonologisch
 S = semantisch
 N = naspreken
 Sel = selectie
 R = reminder
 MB = mondbeeld

Appendix 2**Dutch manual of the BOX treatment**

BOX – Semantische Therapie:
Therapeutische Richtlijnen in functie van de CIAT/BOX Afasietherapie
Studie bij Vloeiende Chronische Afatici

Ineke Wilssens – AGW Logopediewetenschap – Universiteit Utrecht – februari 2009

1. Setting

Min. één en max. twee patiënten zitten samen in een lokaal met 1 of twee therapeut(en). Elke patiënt zit apart aan een tafel (Figuur 1).



Figuur 1 BOX sessie in het ZNA Middelheim

2. Procedure & Richtlijnen (zie handleiding BOX, Visch-Brink & Bajema, 2001)

Patiënten oefenen 3x 45 min. met telkens 10 tot 15 min. pauze (totaal= 3 uur). Patiënten krijgen 9 à 10 opeenvolgende weekdagen therapie volgens het schema in figuur 2. Ook de patiënten die alleen de BOX interventie volgen, volgen dit schema alternerend (=dag 1 schema 1, dag 2 schema 2, dag 3 schema 1...).

Er wordt individueel gewerkt. De therapeut bepaalt aan de hand van de pretesting het lexicaal-semantische niveau van de patiënt. Het niveau van de oefeningen wordt verder proefondervindelijk aangepast op basis van de prestatie van de patiënt. Elke patiënt krijgt telkens een individueel bepaald aantal items van een oefening visueel aangeboden. De patiënten starten allen met bijvoorbeeld 10 items, waarna het aantal items dat telkens wordt aangeboden, aangepast kan worden. De therapeut zal telkens één patiënt assisteren terwijl de overig patiënten de oefening zelfstandig maakt. Zo kan de therapeut van elke patiënt het niveau inschatten en de patiënt van

(Appendix 2)**Dutch manual of the BOX treatment**

individuele feedback (= aangeven of het goed of fout is) voorzien. Het beste is dat de patiënt oefeningen maakt waarbij hij/zij na enig nadenken “een gerede kans heeft tot een goede oplossing te komen” (Visch-Brink, 1997). Wanneer de patiënt de oefeningen te snel kan maken, zal het leereffect klein zijn. Het geven van te veel hulp houdt het gevaar in dat het denkproces van de patiënt te weinig gestimuleerd wordt (Visch-Brink, 1997). Bovendien benadrukt Visch-Brink (1997) dat te moeilijke oefeningen waarbij de patiënt veel hulp nodig heeft te frustrerend zijn. De therapeut functioneert dus eerder als een “goed/fout reflecteerder”. Het doel is om zo zuiver mogelijk lexicaal-semantisch met de patiënten te oefenen. Dit betekent dat de patiënten de oefeningen zo min mogelijk luidop lezen. Taalproductie wordt bij deze vorm van therapie niet vereist. De oefeningen starten op woordniveau en worden uitgebreid naar zins- en tekstniveau in latere sessies. De therapeut tracht ook gradueel het niveau van de patiënt te verhogen. Eventueel kan de therapeut ook de variatiemogelijkheden op de oefeningen aanbieden. De therapeut houdt zich echter strikt aan de handleiding.

Therapie schema		Therapie schema	
1	2	1	2
A: 30 T		A: 30 I	
B: 15 I		B: 15 T	
pauze		pauze	
A 30 I		A 30 T	
B 15 T		B 15 I	
pauze		pauze	
A 30 T		A 30 I	
B 15 I		B 15 T	
75 T		60 T	
60 I		75 I	

Figuur 2 Therapie schema BOX

Legende: A=eerste blok van 45 min (30 min), B=tweede blok van 45 min (15min), T=therapie sessie, I=individuele werk sessie.

Referenties

- Visch-Brink EG (1997) Reply: let's do semantics: wanted: an experienced therapist. *Aphasiology*;11:1106–1115
- Visch-Brink EG and Bajema IM (2001) *BOX: Een semantisch therapieprogramma*. Lisse, Netherlands: Swets & Zeitlinger.

Appendix 3

Nouns/Verbs	Frequency on 100000 Dutch Words	Low/Medium/High Frequent
aankomen	81	HF
aankruisen	0	LF
aanrecht	5	LF
aantrekken	49	HF
aardappelschiller	0	LF
aardbeving	7	LF
ademen	38	MF
after-shave	1	LF
afwasmachine	0	LF
altaar	12	LF
antenne	4	LF
antwoorden	206	HF
appelsap	1	LF
baard	23	MF
bad	24	MF
badhanddoek	1	LF
badjas	4	LF
badjas/badmantel/kamerjas	4/1/5	LF
badkamer	24	MF
badkostuum/badpak	0/3	LF
badkuip	4	LF
badschuim	0	LF
bakken	21	MF
bakplaat	0	LF
bank	114	HF
bed	300	HF
bed	300	HF
beenwarmer	0	LF
beha	5	LF
beker	15	MF
bevatten	96	HF
bezem	4	LF
bidden	42	MF
bier	64	HF
bij	8	LF
blazen	41	MF
blikje	7	LF
blikopener	1	LF
blind	1	LF
bloem	94	HF
bloembol	1	LF
bloemen	0	LF

(Appendix 3)

Nouns/Verbs	Frequency on 100000 Dutch Words	Low/Medium/High Frequent
bloempot	2	LF
blos	6	LF
floszijde	0	LF
bodylotion	0	LF
boeien	31	MF
boek	387	HF
boeken	12	LF
boekenkast	5	LF
boekenrek	1	LF
boom	137	HF
boot	67	HF
bord	64	HF
boren	12	LF
boter	23	MF
boterham	18	MF
botermesje	0	LF
botsen	12	LF
bowling	0	LF
braadpan	1	LF
braadslee	0	LF
breken	112	HF
brievenbus	6	LF
brik (appelsap)	0	LF
broek	61	HF
broek	61	HF
brood	70	HF
brood	70	HF
broodrooster	1	LF
brownie	-	LF
brug	52	HF
bubelbad	0	LF
buigen	76	HF
bureau	88	HF
busstation	1	LF
cake	0	LF
champagne	23	MF
Chinese muur		LF
chips	4	LF
chocolade	5	LF
chocolademelk	1	LF
cirkelen	6	LF
cola	5	LF

(Appendix 3)

Nouns/Verbs	Frequency on 100000 Dutch Words	Low/Medium/High Frequent
communisme	12	LF
das/plastron	7/0	LF
deegroller	0	LF
deken	33	MF
dessert	5	LF
deur	376	HF
deurmat	0	LF
dinosaurus	1	LF
doek	16	MF
donut	-	LF
douche	17	MF
dragen	282	HF
dressoir	3	LF
droogtrommel	0	LF
dweilen	2	LF
eekhoorn	3	LF
eend	24	MF
ei	67	HF
eten	103	HF
ezel	12	LF
fles	112	HF
fluitketel	1	LF
fornuis	5	LF
garage	15	MF
gebak	4	LF
gebakje	2	LF
gel	0	LF
gieter	1	LF
glas	153	HF
glas	153	HF
goochelen	1	LF
gootsteen	3	LF
gootsteen	3	LF
gordijn	45	MF
gras	62	HF
gras	62	HF
grasmachine/grasmaaier	0/0	LF
graszode	0	LF
grill	1	LF
haag	2	LF
haarborstel	0	LF
haard	15	MF

(Appendix 3)

Nouns/Verbs	Frequency on 100000 Dutch Words	Low/Medium/High Frequent
haardroger	0	LF
haarspeld	1	LF
hakmes	1	LF
hand	1028	HF
toetsen	23	MF
handdoek	16	MF
handdoekenrek	0	LF
hark	2	LF
harp	2	LF
heks	1	LF
hemd	24	MF
hert	7	LF
hesp	1	LF
hoek	111	HF
hoorntje	0	LF
houten	61	HF
huis	630	HF
ijs	28	MF
ijsblokje	2	LF
japon/nachtjapon/nachtjurk	11/2/0	LF
jeans/jeansbroek	4/0	LF
jogging	0	LF
jojo	1	LF
jurk	42	MF
kaart	88	HF
kaas	53	HF
kaatsen	3	LF
kader	67	HF
kalkoen	3	LF
kam	8	LF
kampvuur	4	LF
karton	8	LF
kast	48	HF
kastrol	0	LF
kauwen	16	MF
kauwgom	2	LF
kegel	3	LF
keuken	95	HF
keukenmixer	0	LF
keukenrol	0	LF
kiezen	178	HF

(Appendix 3)

Nouns/Verbs	Frequency on 100000 Dutch Words	Low/Medium/High Frequent
kikker	9	LF
kinderstoel	1	LF
kip	33	MF
kleding	23	MF
kleerkast	4	LF
klemmen	28	MF
klutsen	1	LF
knie)kussen	29	MF
knippen	26	MF
koe	36	MF
koeken	0	LF
koekje	8	LF
koelkast	8	LF
koffie	111	HF
koffiezetaaparaat	0	LF
kom	34	MF
komen	3186	HF
kostuum	12	LF
kousbroek	0	LF
krakeling	0	LF
kruidenrekje	0	LF
kruimeldief	0	LF
kruiwagen	5	LF
krultang	0	LF
laars	27	MF
ladenkast	1	LF
leeuw	23	MF
lekkernij/ijss&chocolade	3	LF
lenzen	0	LF
lepel	18	MF
limonade	5	LF
lippenstift	3	LF
lippenzalf	0	LF
lolly	0	LF
luchtballon	1	LF
maan	65	HF
maanlanding	1	LF
maatbeker	0	LF
make-up	6	LF
maretak	1	LF
margarine	3	LF
mascara	1	LF
medicijnkastje	1	LF

(Appendix 3)

Nouns/Verbs	Frequency on 100000 Dutch Words	Low/Medium/High Frequent
mes	41	MF
messenblok	-	
mestverspreider	0	LF
metsen	0	LF
microgolf	1	LF
middernacht	12	LF
mier	7	LF
mineraalwater	2	LF
mixer	1	LF
mocassin	1	LF
mok	2	LF
muffin	-	LF
mug	6	LF
muis	21	MF
muis	21	MF
muur	147	HF
muur	147	HF
nagelknipper	0	LF
nagellak	1	LF
nagelschaar	0	LF
nagelvijl	0	LF
nemen	1031	HF
net	23	MF
nietmachine	0	LF
olie	52	HF
olijf	3	LF
olympisch	7	LF
onderbroek	8	LF
onkruid)trimmer	0	LF
ontwaken, wakker worden	24	MF
oogschaduw	0	LF
openen	114	HF
opener/flesopener/aftrekker	1/0/0	LF
opladen	3	LF
oprollen	10	LF
optellen	4	LF
opzetten	28	MF
oven	12	LF
paard	158	HF
paasei	1	LF
palet	0	LF
pan	35	MF
pannekoek	4	LF

(Appendix 3)

Nouns/Verbs	Frequency on 100000 Dutch Words	Low/Medium/High Frequent
pantoffel	5	LF
panty/pantykous	1/0	LF
pepervaatje	0	LF
perforator	0	LF
pincet	2	LF
pinguin	1	LF
pizza (mes)	1	LF
pizza (pan)	1	LF
plank	34	MF
pleister	7	LF
potje	6	LF
prikwater	0	LF
raam	174	HF
rasp	1	LF
rat	23	MF
rek	11	LF
remmen	17	MF
rendier	1	LF
reukwater/parfum	0	LF
riek	1	LF
rietje	2	LF
rijf	0	LF
roerei	1	LF
rok	31	MF
rollerskate/rolschaats	0/1	LF
(rook)detector	1	LF
rug	180	HF
ruimteschip	4	LF
salopette	0	LF
sandaal	7	LF
sauspan	0	LF
scampi	0	LF
schaap	26	MF
schakelaar	3	LF
schakelpaneel	0	LF
scharnier	3	LF
scheerapparaat	1	LF
scheercreme	0	LF
scheermes/scheermesje)	3/2	LF
schemerlamp	3	LF
scheren	0	LF
schoffel	1	LF
schommelstoel	2	LF
schop	3	LF
schotel	13	LF

(Appendix 3)

Nouns/Verbs	Frequency on 100000 Dutch Words	Low/Medium/High Frequent
schoteltje	2	LF
schrijven	77	HF
schudden	124	HF
schuivers	0	LF
serviet	2	LF
sfinx	2	LF
shampoo	1	LF
shorts	1	LF
sirene	1	LF
slakom	0	LF
slang	27	MF
slip	4	LF
smelten	19	MF
sneeuwman	1	LF
snelkoker	0	LF
sniijden	63	HF
snijplank	0	LF
snoeischaar	0	LF
snoeitang	0	LF
snoep	2	LF
soepketel	0	LF
soepkom	0	LF
sofa	9	LF
sok	13	LF
spaan	0	LF
spade	2	LF
spiegel	51	HF
spiegelei	1	LF
spin	9	LF
spons	4	LF
sportschoenen	1	LF
sproeiflacon	0	LF
stapelbed	0	LF
starten	21	MF
steak (mes)	1	LF
stempelen	4	LF
stijltang	-	LF
stoel	151	HF
stoomketel	1	LF
stoplicht	3	LF
strijkplank	0	LF
struik	30	MF

(Appendix 3)

Nouns/Verbs	Frequency on 100000 Dutch Words	Low/Medium/High Frequent
taart	10	LF
taartje	1	LF
taartvorm	0	LF
tafel	247	HF
tak	54	HF
talkpoeder	1	LF
tampon	1	LF
tand	89	HF
tandenborstel	4	LF
tandenstoker	0	LF
tandpasta	3	LF
tang	5	LF
tapijt	17	MF
tas	38	MF
tekenen	62	HF
thee	51	HF
theelepel	15	MF
thermometer	3	LF
tikken	39	MF
toilet	19	MF
tomatensap	0	LF
ton	30	MF
tosti-apparaat/-ijzer/-toaster	0	LF
traan	77	HF
trap	116	HF
trui	20	MF
truweel	0	LF
T-shirt	4	LF
(tuin)handschoenen	13	LF
tuinschaar	0	LF
tuinslang	1	LF
uil	8	LF
vaas	12	LF
varken	23	MF
veenbes(sensap)	0	LF
verbinden	69	HF
vergiet	0	LF
verlichten	26	MF
verrekijker	6	LF
vertakken	2	LF
vest	0	LF
vijl	1	LF
viking	5	LF

(Appendix 3)

Nouns/Verbs	Frequency on 100000 Dutch Words	Low/Medium/High Frequent
viool	12	LF
vis	73	HF
vleermuis	6	LF
vlieg	18	MF
vliegen	100	HF
vloerkleed	5	LF
vogel	96	HF
voorsnijmes	0	LF
voorsnijvork	0	LF
vork	12	LF
vos	7	LF
vragen	804	HF
vrijheidsbeeld	0	LF
vuilbak/vuilnisbak	0/0	LF
vuilbak/vuilnisbak	0/0	LF
vuur	104	HF
vuurvast	1	LF
wafel	2	LF
wafelijzer	0	LF
wandelstok	5	LF
wasknijper	1	LF
wasmachine	3	LF
wasmand	1	LF
wasverzachter	0	LF
water	364	HF
watercloset	0	LF
watten	0	LF
wattenstaafjes	0	LF
weegschaal	5	LF
wekker	7	LF
wesp	4	LF
whisky	22	MF
wijn	230	HF
wok	2	LF
wolf	17	MF
woonkamer	16	MF
worm	10	LF
yoghurt	3	LF
zak	113	HF
zeef	-	
zeep	16	MF
zettel	15	MF
zetten	417	HF

(Appendix 3)

Nouns/Verbs	Frequency on 100000 Dutch Words	Low/Medium/High Frequent
zon	46	MF
zoutvat/zoutvaatje	0/0	LF
zuigen	31	MF
zwabber	0	LF

Appendix 4

Dutch Translation of the Communicative effectiveness index (CETI)

Gelieve volgende vaardigheden te beoordelen bij uw familielid:
Hoe goed kan de patiënt(e):

1. bewust de aandacht van anderen trekken:

kan hij / zij absoluut niet	<hr/>	kan hij / zij even goed als voor de aandoening
--------------------------------	-------	---

2. aan een gesprek deelnemen waarin het over hem / haar gaat:

kan hij / zij absoluut niet	<hr/>	kan hij / zij even goed als voor de aandoening
--------------------------------	-------	---

3. vragen correct beantwoorden met ‘ja’ of ‘nee’:

kan hij / zij absoluut niet	<hr/>	kan hij / zij even goed als voor de aandoening
--------------------------------	-------	---

4. zijn / haar gevoelens uitdrukken:

kan hij / zij absoluut niet	<hr/>	kan hij / zij even goed als voor de aandoening
--------------------------------	-------	---

5. duidelijk maken dat hij / zij begrijpt wat hem / haar gezegd wordt:

kan hij / zij absoluut niet	<hr/>	kan hij / zij even goed als voor de aandoening
--------------------------------	-------	---

(Appendix 4)

6. een koffie drinken met bekenden (thuis of in het ziekenhuis) en zich daarbij vermaken:

kan hij / zij absoluut niet		kan hij / zij even goed als voor de aandoening
--------------------------------	--	---

7. een persoonlijk gesprek met u voeren:

kan hij / zij absoluut niet		kan hij / zij even goed als voor de aandoening
--------------------------------	--	---

8. de naam van iemand uitspreken die voor hem / haar staat:

kan hij / zij absoluut niet		kan hij / zij even goed als voor de aandoening
--------------------------------	--	---

9. meedelen wanneer hij / zij gezondheidsproblemen heeft (v.b. duidelijk maken waar hij / zij pijn heeft):

kan hij / zij absoluut niet		kan hij / zij even goed als voor de aandoening
--------------------------------	--	---

10. een spontaan gesprek voeren (bijvoorbeeld een gesprek beginnen of van thema veranderen):

kan hij / zij absoluut niet		kan hij / zij even goed als voor de aandoening
--------------------------------	--	---

(Appendix 4)

11. iets zonder woorden uitdrukken (vb. ‘ja’ of ‘neen’):

kan hij / zij absoluut niet		kan hij / zij even goed als voor de aandoening
--------------------------------	--	---

12. een gesprek met mensen aanknopen die niet tot zijn / haar familiekring behoren:

kan hij / zij absoluut niet		kan hij / zij even goed als voor de aandoening
--------------------------------	--	---

13. geschreven taal (woorden, zinnen en teksten) lezen en begrijpen:

kan hij / zij absoluut niet		kan hij / zij even goed als voor de aandoening
--------------------------------	--	---

14. deelnemen aan een gesprek dat snel en met meerdere gesprekspartners gevoerd wordt:

kan hij / zij absoluut niet		kan hij / zij even goed als voor de aandoening
--------------------------------	--	---

15. deelnemen aan een gesprek met vreemden:

kan hij / zij absoluut niet		kan hij / zij even goed als voor de aandoening
--------------------------------	--	---

16. iets heel nauwkeurig beschrijven of bespreken:

kan hij / zij absoluut niet		kan hij / zij even goed als voor de aandoening
--------------------------------	--	---

Appendix 5

Therapie Tevredenheidsschaal

Naam participant:

Datum sessie:

____ (maand) 20____ (jaar)

Therapiegroep:

Geef met behulp van de volgende schaal aan in hoeverre u het eens of oneens bent met de volgende uitspraken:

1. Ik ben tevreden dat ik deelgenomen heb aan de therapie

1	2	3	4	5	6	7
Sterk mee oneens		Neutraal			Sterk mee eens	

2. Ik zou terug deelnemen in het geval er een tweede therapieperiode georganiseerd zou worden

1	2	3	4	5	6	7
Sterk mee oneens		Neutraal			Sterk mee eens	

3. Sedert de therapie communiceer ik beter.

1	2	3	4	5	6	7
Sterk mee oneens		Neutraal			Sterk mee eens	

4. Ik vind de drie uur durende therapiesessies in een periode van 10 dagen haalbaar.

1	2	3	4	5	6	7
Sterk mee oneens		Neutraal			Sterk mee eens	

(Appendix 5)

5. Ik vind de therapiesessies aangenaam.

1	2	3	4	5	6	7
Sterk mee oneens		Neutraal			Sterk mee eens	

6. Ik verkies een korte en intensieve behandeling in plaats van een lange en minder intensieve behandeling.

1	2	3	4	5	6	7
Sterk mee oneens		Neutraal			Sterk mee eens	

Appendix 6

Case	Reference	Case	Age	Sex	HA	ED	MPO	Aetiology	Aphasia Type	Severity
1	Pulvermüller et al. (2001-2005)	7	49	F	R	10	16	-	Wernicke	moderate
2	Pulvermüller et al. (2001-2005)	1	70	M	R	13	48	-	Wernicke	severe
3	Pulvermüller et al. (2001-2005)	4	53	M	R	10	172	-	Anomisch	mild
4	Pulvermüller et al. (2001-2005)	6	59	M	R	13	84	-	Broca	mild
5	Pulvermüller et al. (2001-2005)	2	72	M	R	10	72	-	Broca	moderate
6	Pulvermüller et al. (2001-2005)	5	39	F	A	10	128	-	Broca	moderate
7	Pulvermüller et al. (2001-2005)	9	49	F	A	10	19	-	Broca	moderate
8	Pulvermüller et al. (2001-2005)	3	55	M	R	13	38	-	Broca	severe
9	Pulvermüller et al. (2001-2005)	10	64	F	R	9	172	-	Broca	severe
10	Pulvermüller et al. (2001-2005)	8	44	M	R	13	233	-	not labelled	moderate
11	Meinzer et al.(2005)	7	69	M	-	-	33	I	Wernicke	mild
12	Meinzer et al.(2005)	27	80	F	-	-	23	I	Wernicke	mild
13	Meinzer et al.(2005)	4	51	M	-	-	13	I	Wernicke	moderate
14	Meinzer et al.(2005)	6	41	M	-	-	70	I	Wernicke	moderate
15	Meinzer et al.(2005)	8	70	F	-	-	38	H	Wernicke	moderate
16	Meinzer et al.(2005)	19	67	M	-	-	116	H	Wernicke	moderate
17	Meinzer et al.(2005)	20	38	M	-	-	53	H	Wernicke	moderate
18	Meinzer et al.(2005)	26	36	F	-	-	32	I	Wernicke	moderate
19	Meinzer et al.(2005)	9	61	M	-	-	81	H	Anomisch	mild
20	Meinzer et al.(2005)	12	39	M	-	-	56	I	Anomisch	mild
21	Meinzer et al.(2005)	15	67	F	-	-	42	I	Anomisch	mild
22	Meinzer et al.(2005)	2	53	F	-	-	32	H	Broca	mild
23	Meinzer et al.(2005)	3	64	M	-	-	24	I	Broca	mild
24	Meinzer et al.(2005)	21	36	M	-	-	12	I	Broca	mild
25	Meinzer et al.(2005)	10	49	F	-	-	71	I	Broca	moderate
26	Meinzer et al.(2005)	11	18	M	-	-	14	H	Broca	moderate
27	Meinzer et al.(2005)	13	51	M	-	-	29	H	Broca	moderate
28	Meinzer et al.(2005)	16	49	M	-	-	92	I	Broca	moderate
29	Meinzer et al.(2005)	22	53	F	-	-	50	I	Broca	moderate
30	Meinzer et al.(2005)	23	47	F	-	-	87	I	Broca	moderate
31	Meinzer et al.(2005)	25	47	M	-	-	29	I	Broca	moderate
32	Meinzer et al.(2005)	1	35	F	-	-	33	H	not labelled	mild
33	Meinzer et al.(2005)	17	41	M	-	-	46	H	not labelled	mild
34	Meinzer et al.(2005)	14	47	F	-	-	54	H	not labelled	moderate
35	Meinzer et al.(2005)	18	66	M	-	-	26	I	not labelled	moderate
36	Meinzer et al.(2005)	5	60	M	-	-	60	I	not labelled	severe
37	Meinzer et al.(2005)	24	56	F	-	-	28	H	global	severe
38	Meinzer et al.(2007)	13	51	M	R	13	59	I	Wernicke	moderate
39	Meinzer et al.(2007)	14	69	M	R	11	67	I	Wernicke	moderate
40	Meinzer et al.(2007)	16	56	M	R	13	48	I	Wernicke	moderate
41	Meinzer et al.(2007)	15	66	M	R	11	35	I	Anomisch	mild
42	Meinzer et al.(2007)	19	65	M	R	11	44	I	Anomisch	mild
43	Meinzer et al.(2007)	3	43	M	R	9	72	I	Broca	mild
44	Meinzer et al.(2007)	4	35	M	R	13	33	I	Broca	mild
45	Meinzer et al.(2007)	5	49	F	R	9	6	I	Broca	mild
46	Meinzer et al.(2007)	9	57	M	R	13	18	I	Broca	mild
47	Meinzer et al.(2007)	10	61	M	R	13	27	I	Broca	mild
48	Meinzer et al.(2007)	20	66	F	R	9	24	H	Broca	mild
49	Meinzer et al.(2007)	2	65	F	R	9	34	I	Broca	moderate
50	Meinzer et al.(2007)	11	62	M	R	11	79	I	Broca	moderate

(Appendix 6)

Case	Reference	Case	Age	Sex	HA	ED	MPO	Aetiology	Aphasia Type	Severity
51	Meinzer et al.(2007)	12	69	M	R	9	30	I	Broca	moderate
52	Meinzer et al.(2007)	17	44	M	R	13	36	I	Broca	moderate
53	Meinzer et al.(2007)	6	61	M	R	11	48	I	Broca	severe
54	Meinzer et al.(2007)	1	44	F	R	9	12	I	not labelled	moderate
55	Meinzer et al.(2007)	7	46	M	R	13	34	I	global	severe
56	Meinzer et al.(2007)	8	41	M	R	11	24	H	global	severe
57	Meinzer et al.(2007)	18	72	M	R	9	43	I	global	severe
58	Meinzer et al.(2008)	1	19	F	R	-	11	H	Broca	mild
59	Meinzer et al.(2008)	10	66	F	R	-	480	I	Broca	mild
60	Meinzer et al.(2008)	6	60	M	R	-	27	I	Broca	moderate
61	Meinzer et al.(2008)	11	42	M	R	-	19	I	Broca	moderate
62	Meinzer et al.(2008)	4	55	F	R	-	30	I	not labelled	moderate
63	Maher et al.(2006)	1	53	M	R	16	48	I	not labelled	moderate
64	Maher et al.(2006)	2	55	M	R	12	36	I	not labelled	moderate
65	Maher et al.(2006)	3	45	F	R	16	47	I	not labelled	moderate
66	Maher et al.(2006)	4	40	M	A	16	24	I	not labelled	moderate
67	Szaflarski et al.(2008)	2	-	M	R	-	-	I	Wernicke	severe
68	Szaflarski et al.(2008)	1	58	M	R	13	24	I	Broca	moderate
69	Szaflarski et al.(2008)	3	64	M	R	16	240	I	Broca	severe

Legend: HA=handedness, ED=years education, MPO=months post onset, M=male, F=female, R=right, A=ambidextrous, '-'=not reported, I=infarction, H=haemorrhages

Appendix 7

Raw scores and mean scores pre- and post therapy on semantic and phonological measures (n=9)

		VSAT pretherapy Max 30	VSAT posttherapy	SWALI pretherapy Max 15	SWALI posttherapy	ASJ pretherapy Max 60	ASJ posttherapy	NR pretherapy Max 30	NR posttherapy	ALD pretherapy Max 160	ALD posttherapy
Case	C1	24	22	6	7	47	49	28	27	149	148
	C2	21	24	14	13	51	51	18	21	131	140
	C3	18	28	6	7	54	52	27	29	156	156
	C4	22	25	8	10	52	53	18	27	129	152
	C5	30	27	13	12	57	57	21	22	157	160
Mean (SD)		23.0 (4.47)	25.2 (2.39)	9.4 (3.85)	9.8 (2.78)	52.2 (3.70)	52.4 (2.97)	22.4 (4.83)	23.4 (6.88)	144.4 (13.52)	151.2 (7.69)
	B1	27	28	12	14	52	59	28	26	159	154
	B2	23	27	8	10	49	55	24	25	141	140
	B3	13	12	3	6	46	46	26	28	139	144
	B4	27	30	12	14	54	58	3	4	124	136
Mean (SD)		22.5 (6.61)	24.25 (8.26)	8.75 (4.27)	11 (3.93)	50.25 (3.5)	54.5 (5.92)	20.25 (11.62)	20.75 (11.24)	140.75 (14.34)	143.5 (7.72)

Legend: Verbal Semantic Word Association (VSAT); Semantic Word Association of Low Imageability (SWALI); Auditory Synonym Judgement (ASJ) Nonword Repetition (NR), Auditory Lexical Decision (ALD). Note: Shaded areas indicate a clinically significant improvement using a change in score on the SAT (≥ 6 points), and a change in score of $\geq 2SD$ from the mean on the Semantic word association for low imageability words (≥ 2 points) on the Auditory synonym judgment (≥ 3 points), the Repetition of nonwords (≥ 3 points) and the Auditory lexical decision (≥ 5 points).

Appendix 8

AAT and BNT raw scores and difference in raw scores pre- and post treatment

case	C1	C2	C3	C4	C5	B1	B2	B3	B4
TTpre (max 50)	29	28	38	39	32	29	24	39	27
TTpost	20	18	28	24	17	20	13	34	26
TTDiff	-9	-10	-10	-15	-15	-9	-11	-5	-1
COpre (max 120)	81	79	88	87	104	103	100	66	104
COpost	92	87	86	96	100	110	113	83	113
COTotDiff	11	8	-2	9	-4	7	13	17	9
REpre (max 150)	144	119	132	116	105	117	136	145	95
REpost	148	124	136	130	108	120	143	143	94
REtotDiff	4	5	4	14	3	3	7	-2	-1
NApre (max 120)	93	96	66	90	99	86	96	48	77
NApost	96	102	75	99	111	105	87	57	104
NAtotDiff	3	6	9	9	12	19	-9	9	27
WL-pre (max 90)	84	82	67	81	66	82	76	79	65
WL-post	87	84	72	82	70	85	73	85	74
WLTotDiff	3	2	5	1	4	3	-3	6	9
BNTpre (max 60)	30	33	7	37	44	37	46	0	33
BNTpost	45	39	17	44	54	46	45	19	49
BNTDiff	15	6	10	7	10	9	-1	19	16

Legend: Aachener Afasie Test (AAT); Boston Naming Test (BNT); Token Test (TT); Comprehension (CO); Repetition (RE); Naming (NA); Written Language (WL); difference (Diff); total (tot); CIAT (C); BOX (B); Note : Shaded areas indicate (1) a critical change in raw as defined by the AAT (TT=8, CO=22, RE=15, NA=17, WL=12) or (2) a change in score of $\geq 2SD$ from the gender, age and education adjusted mean normal performance on the BNT

Appendix 9

AAT subscales raw scores pre- and post treatment

	case								
	C1	C2	C3	C4	C5	B1	B2	B3	B4
RE4pre (max 30)	29	22	18	20	17	18	26	29	9
RE4post	29	22	23	26	10	16	29	29	12
RE5pre (max 30)	27	14	24	12	9	13	25	28	9
RE5post (max 30)	29	16	23	18	12	16	25	26	11
NA2pre (max 30)	27	28	16	28	30	30	23	14	30
NA2post	27	28	25	27	30	30	18	15	30
NA3pre (max 30)	25	20	12	23	19	17	25	10	16
NA3post	22	22	12	24	28	26	22	12	28
NA4pre (max 30)	16	21	18	13	20	14	24	7	10
NA4post	21	23	18	25	23	20	20	13	16
WL3pre (max 30)	26	28	23	26	11	27	23	26	15
WL3post	27	27	29	25	17	27	20	27	21

Legend: Aachener Afasie Test (AAT); Repetition compounds (RE 4); Repetition Sentences (RE5); Naming Colors (NA2); Naming Composed Nouns (NA3); Naming Sentences (NA4); Written Language dictational writing (WL3); CIAT (C); BOX (B); Note Shaded areas indicate a critical change in raw score as defined by the AAT

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